THE

ELECTRICAL REVIEW.

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J. A. BERLY'S

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THE

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COMMERCIAL CONDENSERS.

AT the present time, when commercial condensers are becoming practical realities in engineering, it is likely that many useful modes of applying them in alternating practice will be brought forward; a short time ago we drew attention to one interesting application in the way of procuring a constant current from a constant pressure supply, and Mr. Wm. Stanley (of alternate arc light dynamo fame) has recently brought out another; this is an application of the condenser to alternate motors.

Recognising the fact that a great deal of trouble and loss is introduced by the want of phase between the current and potential in all present types, Mr. Stanley has set himself to design a motor which should have this difficulty to a large extent eliminated, and at the same time should be capable of running from an alternate supply as easily as an ordinary motor will from a direct supply, with only one circuit.

This he gets by a combination of devices. In the first place he puts in the field magnet circuit a condenser of such capacity, that the current through the fields just develops enough potential difference at the terminals of the condenser to neutralise the back E.M.F. of self-induction. Since the condenser and self-induction E.M.F. are exactly opposite in phase, he thus gets rid of the trouble he would have in getting his fields properly magnetised, as the circuit is practically without inductance. In the case of the armature, a different procedure is utilised: surrounding it, but fixed to the machine, and thus stationary, are very low resistance copper bands, so placed that the currents induced in them by the armature currents flow parallel to the latter; since they are exactly opposite to these, there is little or no resultant magnetism in the armature. This ingenious device does away with several troubles; hysteresis and foucault current losses are practically nil, and we also get the important advantage of doing away with nearly all the cross magnetisation, thus avoiding change of lead under variation of load.

It is evident that since the regulation of the fields depends on the balancing of a condenser E.M.F. against a self-induction one, the rate of alternation enters as a factor, and hence the goodness of the adjustment depends on the speed of the engine; this is said, however, not to be very serious.

Mr. Stanley has himself produced a condenser for this work, but, unfortunately, he tells us nothing about it, and so one cannot yet say whether this ingenious motor will be a practical success, or whether the price will not be very high; probably its chief use will be in small power installations, and not for transmission purposes. For this there is probably not much to choose between synchronous and drehstrom motors.

There seems certainly a great and promising future for a good commercial condenser; whether any of those yet brought out will be successful, it is probably premature to prognosticate.

INSULATION RESISTANCE AND ELECTRIFICATION.

During the last two or three months a good deal has been spoken and written about the insulation of electric light conductors, and the best method of specifying for the same; and we have on more than one occasion referred more especially to the importance, when specifying tests to which the cable is to be subjected, of stating exactly the conditions under which such tests should be made. This is a point that in the past has been much neglected by electric light engineers; and even now, although it is usual to find that the temperature at which the test is to be made is stated, we notice that in the majority of cases no reference is made in specifications to the time during which the process of electrification is to continue before the reading is taken from which the insulation resistance is to be calculated.

This may be due to the fact that it is generally assumed that the test will be taken after one minutes' electrification; but we believe that this is not an altogether universal practice, and even if it were so, it would be quite as necessary to state it in the specification as to state that the cable should be tested in water at 60° Fahr. It is, however, possible that laxity in this matter arises from the immense variation in the apparent resistance of some dielectrics after different periods of electrification not being fully recognised, and we have therefore prepared a table from tests which have been communicated to us by one of the leading cable manufacturers, which will show how great this variation is in cables insulated with vulcanised India-rubber.

Insulation Resistance of Vulcanised Rubber Cables Tested in Water at 60° Fahr.

Conductor.	Insulation resistance in megohm miles after				
	1 minute.	2 minutes.	3 minutes.	4 minutes.	5 minutes.
19/16	592	964	1,224	,700	1,927
19/18	585	929	1,161	1,580	1,975
7/16	607	975	1,215	1,633	1,980
19/18	940	1,463	1,975	2,255	2,633
„	1,097	1,580	1,975	2,255	2,633
7/16	1,215	2,025	2,468	2,925	3,590
19/15	6,768	10,831	12,036	15,476	18,055
„	6,664	9,769	11,941	15,353	17,911
„	6,549	9,826	12,282	16,375	19,652

From the figures here quoted it will be seen that the apparent resistance, after three minutes' electrification, is, roughly speaking, twice that after one minute; and that after five minutes the apparent resistance is about three times that after one minute. A somewhat similar increase of resistance was noted in Hooper's core, the apparent resistance after ten minutes' electrification being about four times that after one minute; and although the rate of increase varies considerably with different qualities of India-rubber, it is always found to be very large, and much in excess of what is generally found with gutta-percha core, a by no means unusual figure for this latter being an increase of about 25 to 30 per cent. between the end of the first and fifth minutes.

The electrification of fibrous insulated cables varies a good deal according to the material with which the fibre is impregnated and the degree of drying, but according to tests published by Herr Heim, the increase of resistance between the end of the first and fifth minutes may be over 100 per cent. We are unable to say if this is a usual figure or not, as very few tests on such cables have been published; and, as the matter is an important one both to makers and users of cables, we should be glad to receive information on this point from manufacturers.

WHY WAS THE "LANCET" SILENT?

At the risk of dealing with stale news, we have waited a whole week to see whether the recent execution in Vienna would call forth a word of protest from that champion of humanity and decency, the *Lancet*. This paper is ostensibly published on Saturdays, although we believe it can be purchased at least two days before the date of publication; we could hardly expect it, therefore, to deal with the revolting execution of the murderer Schneider until March 26th. But not a single reference to it is to be found.

All the morning papers were agreed that in the whole records of modern horrors, nothing more gruesome and disgusting occurs than the accounts of the manner in which this miserable miscreant, Schneider, was done to death in a Viennese prison. Atrocious as the ruffian was, society might have taken its revenge in more seemly fashion. The man was simply strangled, not wholly with a rope, but by the hands of another man, his neck being encircled by a white silken cord, such, perchance, as one of the great ladies of the Hofburg might buy in the Graben to deck her own dainty waist. While the executioner held nose and mouth to prevent respiration, the white silk cord was slowly doing its work by the weights of the victim and the executioner and his two assistants, who were horse-slaughterers, borrowed from the knacker's yard of the Austrian capital. To quote from the *Daily Chronicle* account: "The executioner placed his left hand upon Schneider's jaw and mouth, and his right over the forehead and eyes, and commenced pressing vigorously. One of the assistants, meanwhile, hung on to the hands of the culprit, and the other, kneeling on the ground, seized his legs, both hands being pressed downwards with his whole weight. Under the grasp of three such powerful men, the doomed criminal was unable to move, and the doctors state that he was dead in four minutes." Compare this with the *instantaneous* death by electrocution. The wretch who suffered deserved no pity, it is true; but surely, when the whole daily press raises its voice against the horrible indecency of this execution, the *Lancet* might be expected to say something, however feeble.

Recent events in our own country have not at all tended to the glorification of the gallows. Even the ex-hangman is doing all he can to prove that hanging is a relic of a barbarous age, which ought to disappear from civilisation before the century closes. Hanging cannot be ensured from horrible indecencies, as we know too well, neither can strangulation or the guillotine; the only method practised now that can ensure instantaneous and decent execution is death by electricity. As the *Pall Mall* said—and this paper has surely ever been the champion of decency:—"The electrocutions in America may not have been very successful (a point which

we do not admit, however), but, at any rate, they were experiments towards a better way of doing criminals to death than obtains in most European countries."

The *Lancet* is admittedly an advocate of capital punishment, and, as we all know, delights in posing as the champion of decency and humanity. Why is it not, therefore, consistent in its protests against everything that ordinary people regard as inhumane? The fact is that the pages of the *Lancet* are too full of those licensed horrors which it terms "vivisection experiments," and it is impossible for it to be consistent in its attitude towards questions of humanity.

Although we should not like to go so far as Mr. Lilly, who, writing from the Athenæum Club a short time ago, spoke of the vivisectionists as "artists in filth and torture," yet we do unhesitatingly affirm that the *Lancet* will occupy a higher *status* in the opinion of laymen if it will be discreetly silent, if it cannot be rigorously consistent, as regards all matters of humanity and decency.

Wattmeter Readings on Alternating Circuits.

Professor Ayrton's well known correction for getting true watts spent in an alternating circuit from the reading of an ordinary wattmeter, is the subject of a communication to a recent number of the *Electrical World*. Mr. Danielson there points out the fact, which in the light of more recent work is fairly evident, that the angle of lag to be used must take into account the retardation in phase due to Foucault currents and hysteresis as well as the ordinary lag. In other words, the value of the resistance to be used in calculating the lag must be the true energy waste factor. This is best got (as the author points out) by taking volt and ampere readings simultaneously with the wattmeter ones, and by combining the correction formula and the ordinary formula for alternate power, a fairly good result is obtainable. It is open to question whether it be worth while applying the correction unless we are using a transformer with very light loads, as the ordinary errors of observation are probably nearly if not quite as large as the correction when a fair output is being taken from the transformer.

Electric Traction in Chicago.

A new system, says the *Manitoba Free Press*, is being experimented with in Chicago, which may to a great extent do away with the objectionable overhead wires. The line, which has just been completed, is nearly one and three-quarter miles long, and is to be worked by a trolley making connection with copper wires supported at intervals of eight feet in an underground conduit. So far there does not appear to be anything strikingly different from some of the systems known in England, but the following remarks which the inventor, Mr. Love, is reported to have made, when undergoing the customary interview, may perhaps make electrical engineers here anxious to get further details:—"My invention will revolutionise the carrying systems of the world. It is simplicity itself; perfect insulation and perfect contact are all there is in it. We can pull heavy trains at any speed desired; we will light and heat the cars, and guarantee to handle 60,000 passengers an hour; we can stop a train going at the maximum speed allowed by the ordinances, within two feet: we can run backward or forward at the same speed; there is no loss of the power, and the conductors will last almost for ever; there can be no breakage, no delay. The loss of power in cable lines by reason of the loops is very great. By my system there can be no such loss. A tremendous power, which can be regulated by a child, drives the train, and it is perpetual."

The Institution of Electrical Engineers.

The circular letter recently sent by the secretary of this Institution stating "that the Council have determined to discontinue the system of furnishing, for the technical press, 'official abstracts' of the discussions taking place at the meetings of the Institution, and each journal henceforth will be permitted to make and publish its own *abstract of such discussions*," has not been sent a moment too early. The technical papers have always taken exception to the policy of the Editing Committee (by whom presumably the matter has been decided), and many strong protests have been made against it. Although occasionally, no doubt, fair abstracts have been made, the reverse has usually been the case, and a wise course has been taken in altering a condition of affairs which was becoming intolerable.

Motors, Meters and Money Matters.

Prof. Ayrton on Friday evening last delivered a lecture before the Royal Institution on "Motors, Meters and Money Matters." In his opening remarks the lecturer spoke of the hazy notions of the average householder concerning ampères, volts, Board of Trade units; they were no more definite, he said, than those of the judges who tried electrical patent cases. [The professor, however, seemed to forget that the judges had not to adjudicate upon technical terms, but to administer the law. But in whatever way we may argue, there is no getting away from the fact that legal training sharpens a man's intellect and enables him to grasp the question at issue more comprehensively and readily than the rest of mankind, professors included.] He then illustrated the passing of the current into and out of the houses, the effect of the current on the instruments used for measuring, and the construction of the instruments. By means of lamps placed in wooden boxes representing houses, the effect of the Board of Trade variations were given. The lower variation of 4 per cent. produced a palpable decrease in light. The lecturer said that experiments made on Edison and Swan lamps showed that for each 1 per cent. variation in the pressure there was 7 per cent. variation in the light, so that 100-v. lamps with a pressure of 96 volts would only give about three-quarters of their normal light. In this way the Board of Trade regulations regarding variation of pressure would cause a 16-C.P. lamp to vary from about 12 to 20-C.P. Public statements had been made that far greater fluctuations than this passed unnoticed, unless the attention of the observer be specially directed to the change. No doubt it was more difficult to observe fluctuations which took place slowly. It was to the credit of the supply companies that, as a rule, they kept well within the legal limits. The lecturer then referred to current curves of some of the principal electric light companies, and described in detail the meters used. In conclusion, Prof. Ayrton spoke of the possibilities of heating by electricity. From exhaustive experiments and calculations he found that a tailor's goose could be properly heated for about 2d. an hour, and using electricity to cook an omelette would cost ½d.

Oil Insulation.

With reference to the attention which is being drawn to the use of oil as an insulator, it has been pointed out by the New York *Electrical Engineer*, that there is one aspect of the question which must not be lost sight of, if we apply this method to telegraphic, and more specially to telephonic and to high tension work. This refers to the high specific inductive capacity of the oils in general, that of rosin oil being equal to, if not greater, than that of gutta-percha. The effect of this increase in capacity in telephone cables must necessarily shorten the effective talking distance to a very large extent; indeed, so narrow is the margin here permissible that dry-paper insulation may now be said to have become the standard of American practice, and involving a capacity of ·075 microfarad per mile, as against ·30 for gutta-percha. The effective capacity of the line in high tension alternating work was only too well shown in the Lauffen-Frankfort transmission, where a large part of the power was absorbed in charging the line alone, necessitating an increased capacity in the generating apparatus for a given power to be delivered at the other end of the line, though no actual expenditure of power takes place.

THE DESIGNING OF DYNAMO ELECTRIC MACHINES.*

By OSBORN P. LOOMIS.

Dynamos may be considered in two classes, namely, those used for supplying a variable current at a constant or nearly uniform pressure (such as those used in incandescent lighting) and those used in supplying a constant current at variable pressures depending on the resistance to be overcome in the external circuit. It might appear to some that the rules of design of a dynamo of one class ought to apply to the other, except in the matter of winding the frames, and it was at one time thought so even among electricians; but as investigation progressed it was found that not only were the requirements different, but different methods of designing were necessary to secure practical results.

The foundation stone of the dynamo-electric machine is magnetism, and in the incandescent machine this is particularly so. The days of slim and skinny dynamos for this work have gone by. The field magnets should be large and as short as compatible with the necessary wire to be wound upon them. The same holds true with regard to the pole pieces, and I think that it is generally conceded among electricians that drum armatures are superior to the ring type for this class of work, except in the case of multipolar dynamos, which embody but another way of reducing the magnetic resistance of the core of the armature by multiplying the number of paths or circuits. With these conditions there is less distortion of the field magnetism upon changes of load put upon the armature.

Contrasted with machines for incandescent lighting, the design of a dynamo for running arc lights might be quite reversed. The frame should be quite light, and the pole pieces should be thinned down, and in this case a ring armature is much to be preferred on account of electrical and magnetic reasons which will appear later.

The winding of dynamos is now generally divided into three classes or sy tems, as follows:—1. Series winding, in which all the current generated by the armature passes around the field magnets to the external circuit. 2. Shunt winding, in which only a part of the current passes around the field. 3. A mixture of the preceding called compound winding. This is a shunt wound dynamo, with the exception that all of the generated current passes around the field magnets a few times only, and assists the shunt magnetism for a regulative purpose.

This type is especially useful in generators for motor and incandescent work, and the object is to produce a constant pressure, and, in some cases, to slightly increase it with increase of load to compensate for loss of potential in the line circuit to the point of consumption. These changes are instantly and automatically made in the dynamo itself without the aid of external appliances which are necessary in the use of a simple shunt-wound dynamo. I might remark that in the early practice of compounding dynamos, this extra magnetic effect in some cases nearly equalled the shunt effect on account of the high resistance of the armatures then built; but in recent dynamos this extra effect is comparatively small, owing to the armatures being wound with few turns of wire.

An additional advantage of the compounding is the strengthening of the field at the same instant the load comes on the armature, because at that time there is a tendency to distortion of the field magnetism, and still better effects result by placing the series or compound coils on the pole-pieces, or, as is sometimes done, over the whole armature. It might be argued that putting them anywhere on the magnetic circuit of the machine would do as well, as the magnetism must keep to the circuit; but in the large pole pieces such as are commonly used, I think that the magnetic lines would be more easily pushed to one side if there were no winding on the pole pieces. I will state that in my experience copper strip has given excellent results, the resistance being very low and the winding very compact.

What is known as series winding is principally used in dynamos for arc lighting, to which it is admirably adapted. This class of generators has, until recently, been much misunderstood. It used to be thought that by shifting the brushes they were moved to points of higher or lower potential on the commutator, which is undoubtedly true, but is not all the truth; for, as the brushes are shifted, the magnetic or polar line is also shifted, and this influences the field to a remarkable extent, owing to the great number of turns on the armature which are necessary to produce the requisite pressure for this class of work. Together with this a comparatively weak field magnetism is used, but is held above saturation by many wire turns in the field bobbins. In this condition of things the armature might be roughly termed a valve which allows more magnetism to pass through itself when the current is lessened (that is, by adding arc lamps), and tending to shut it off when the current is increased, as when lamps are cut out.

These effects are due, principally, to the peculiar construction of this armature running in a nearly constant field. These principles are taken advantage of by Mr. Stanley in his constant current alternating dynamo, which automatically produces a uniform current from the capacity of the machine down to a short circuit. Of course, in a continuous current machine these actions are supplemented by an automatic regulator which shifts the brushes, and, as above stated, changes the polar line of the armature, which intensifies these effects.

Attention is called to the stability of current in these dynamos. An arc light is a very unsteady resistance, and it will be seen that if the field were responsive to these changes, we would have anything but a constant current. This explains why it is necessary to put so little iron in the field magnets. Under these conditions they are above the saturation point, and changes of the current in the field coils produce little change in magnetism. If this were not done there would be a periodic rise and fall of current and E.M.F.

In dynamos that produce a variable current with a constant or nearly uniform pressure at their terminals, nearly the opposite course in design must be followed. The fields should be large and thick, or be made multipolar, which is another, and in many respects better way of securing the same result. The magnetic effect of the armature should be made small by winding few turns of wire upon it. Electricians have been slowly but surely tending towards this point and, in proportion, better results have been realised. Another advantage secured in this design is the slight change in the non-sparking points on the commutator. This is due, of course, to a very weak armature running in a strong field, magnetically speaking.

Another extremely important point is that of diminishing the air gap by winding the armature with only one layer of wire. This reduces the resistance of the magnetic circuit, and renders it less liable to distortion under the varying currents delivered by the armature. If it were possible to find a suitable magnetisable substance which was at the same time a good conductor of electricity (say like copper), I think we could build what might be termed a commercially perfect dynamo (that is of this class); for with no air gap we could keep the polar line of the field perfectly steady. Consequently, what is termed the neutral or non-sparking points on the commutator would never shift, and that trouble, known as sparking, over which electricians have heaved so many sighs, would be for ever at an end. As this dream is certainly not realised at the present time, the next best thing we can do is to approach it as nearly as possible by reducing this air gap to its lowest limit. It is better to increase the circumference of the armature core in order to get the surface room, than to put on the necessary turns in two layers, for the increased iron in the core is to the air space as 1 in 20,000. Added to this is the advantage of a higher peripheral velocity of the armature wires.

If it is desired to secure extra fine results in special requirements, it would be profitable to allow the surface of the poles to come down close to the conducting wire and bore slightly larger for the binding bands. It might not appear that the results would warrant the trouble, but it can easily be demonstrated.

In regard to armature cores I notice it has been the practice with some builders to carefully insulate the sheet iron discs from the shaft by a non-conducting sleeve. This certainly increases the magnetic resistance of the armature, and

* A paper read before the Electrical Section of the Brooklyn Institute.

in my experience I have found it wholly unnecessary. By slipping the discs upon the armature shaft directly I have not been able to discover any heating. It certainly saves trouble, and at least ought to produce the same results.

Of late there has been some tendency to the use of laminated cores for field magnets. Apart from the better quality of iron, I cannot see any advantage in this practice, for the following reason: All lamination is used to break up circulating currents in the metal subject to magnetic changes, of which an armature is an excellent example; but with the exception of a dynamo using a toothed armature I think that it is generally understood that no magnetic changes occur in the field of a dynamo, or at least not with the frequency necessary for this precaution. In the case of a toothed armature I think a laminated pole piece would be sufficient for all practical purposes, of course, referring to continuous current dynamos.

In practice I find good results by making the width of the pole piece equal to the diameter of the core. The following data of a machine embodying the principles just enumerated may be of interest:—

Data of 16 *Kilowatt Dynamo.*

110 volts; 150 ampères; 1,400 revolutions.

Resistance of armature	·022	ohm.
„ „ series coil	·005	„
„ „ shunt fields	20·00	ohms.
Area of cross section of each core	48·6	sq. in.
„ „ „ pole piece... ...	107·5	„
60 turns on armature in one layer.		
24 „ „ series coils.		
4,088 „ „ shunt fields.		
Cross section of wire on armature	25,998	sq. mils.
„ „ „ copper strip on series ...	138,000	„
„ „ „ wire on shunt fields ...	5,128	„

There are some few practical points in regard to commutators and brushes worth mentioning. A brush should bear with a firm elastic pressure on the surface of the commutator. If the spring is not stiff enough, any little unevenness on the commutator will cause the brush to jump from the surface, and then trouble commences and grows worse instead of better. By using a firm spring the brush will be held to the surface, regardless of slight projections. Again, the brush holders should be free to slide laterally on the studs to allow the brushes to be placed on the surface of the commutator so as to break joints, thus keeping it free from ridges.

When the commutator pits out at one segment repeatedly, a defective joint will generally be found at the junction of the wires and bar. The explanation is that as the brush leaves a good connection and strikes a poorer one, a spark is formed repeatedly and gradually eats it away.

It might be thought that the electrical part of the dynamo was all that was worth talking about, but I might mention a little incident. While conversing with a mechanical engineer of considerable experience, he remarked that electricians had to learn mechanical experience all over again in the matter of journals, which had not been made long enough in the past. They should be made large, not because a larger bearing in itself runs cooler, but because large shafts do not spring out of line while running.

Turning toward the subject of lubrication, there are several forms of self-oiling journals in use, and they generally give satisfaction, being automatic and much cleaner in their operation. A form recently designed consists of a woven chain ribbon running over, or carried by, a serrated surface on the shaft. I think that this may have some advantages over the ring, as it seems to gather up more oil. There are many that think the old oil cups are good enough, but I am sure a little experience with a self-oiling machine would secure their preference.

Long Life of an Incandescent Lamp.—According to the *Electrical World*, Mr. H. J. Wells, superintendent of the Osceola Light Company, Osceola, Pa., reports that a Sawyer-Man lamp on one of the circuits of that company has just closed a remarkable record. The lamp in question was constructed for an electromotive force of 110 volts, and was run as nearly as possible at that voltage. Its normal brilliancy was 32 C.P. The lamp was placed in circuit February 22nd, 1890, and remained in service with an average use of 8½ hours per day until March 5th, 1892.

ELECTRICITY IN ITS RELATION TO MINING.

By ERNEST SCOTT.

No. II.

(*Continued from page* 60.)

Danger of Fire.

The danger of fire by sparking at the brushes and the commutator is neutralised by covering in either the commutator alone or the whole of the armature with gas tight metal cases, doors and windows being fitted in.

Messrs. Davis and Son enclose the commutator, and therefore reduce the enclosed space to a minimum. The commutator is inverted, the brushes being inside. The door or end disc is so arranged, that the machine will not work unless it is in its closed position, and it is therefore equivalent to a locked safety lamp. The junction between the fixed and the revolving portions of the machine is made by a flame-tight joint.

Messrs. W. T. Goolden & Co. enclose the whole of the armature, and therefore protect against the danger of short circuits in the wire, and prevent anything getting between the armature and the magnet. There is no ventilation through the armature; but it is found that this does not cause undue heating, the heat being conducted to the covers and away by radiation and convection currents. It is merely a question of giving a rather large cooling surface than would be allowed if the machine had not got the covers.

Below two square inches per watt lost in heat in the armature will keep the temperature of an enclosed motor within 80° above that of the atmosphere.

The magnet coils, terminals, switches, and resistances are also placed in gas-tight metal boxes, so that the motors may be safely run in fiery places, and to serve as protective coverings.

These coverings have been tested on several occasions in gaseous mixtures.

A motor fitted with the Davis and Stokes's commutator covers was tried in an explosive mixture, which fired and burnt in a safety lamp, so that the lamp had to be taken out to prevent the gauze getting red hot and exploding the gas. The motor was then run with perfect safety for half an hour in the mixture, the brushes being purposely made to sparkle all the time. At the end of the test, a hole was cut in the mica window, when the gas fired at once, the commutator and brushes having become heated to a very high temperature.

The Messrs. Atkinsons' put a "Goolden" enclosed motor for five hours in an atmosphere of coal gas, and at the end of that time found that only ·5 per cent. of the gas had percolated through the joints. It would therefore have taken 25 hours before it had got dangerous, and one would have to use a great stretch of imagination to expect anything half as bad as that to occur in practice.

The next objection is that the cables might be broken, and an arc formed between the ends. In a colliery where falls are frequent, the cables should be buried below the floor; but where the roofs are good, it is the usual practice to carry the wires on insulators, a good serviceable job being made of them. After numerous enquiries at collieries, where the electric plant is laid down, and the cables properly put up, not a single accident of this kind is reported. It is again simply a case of workmanship.

The Messrs. Atkinson have, however, devised a safety mining cable which promises very well. This cable consists of two parts, the internal being made up of several small copper wires wound in the form of a spiral, and capable of almost indefinite extension. These are thinly braided over, the cable proper of the required sectional area is then laid on, this being of course insulated in the usual way. The idea is that in the event of a breakage and consequent spark, this spark shall be made to show itself in a suitable apparatus on the pit bank instead of at the point of fracture. The apparatus takes the form of a fusible cut-out and knock-off switch, which can be conveniently fixed on the main switchboard. A resistance is put in between the internal and external conductors at the motor end of the cable. The action is as follows:—

If the outside cable only is broken, the extensible spiral

conductor has for an instant to carry the whole current. The fuse, therefore, at once melts, the weight is dropped, and the main current is broken by its knocking out the switch.

If the cable is bruised so that the two wires touch, or if both the wires are cut clean in two, then, owing to the potential at the extreme ends of the cable being the same, and there being a small potential difference between the two conductors all along the line, the resistance is short circuited, and there is a momentary rush of current, the fuse melts, and the main switch is broken as before. The insulation between the two wires is only very thin, and we should have to imagine an exceedingly sharp non-conducting instrument which would cut across the wire without bringing them into contact, an impossibility, in fact.

Shocks.

For underground work, no current at a greater pressure than 700 volts should be used, electrical engineers being agreed that below that pressure there is no danger to human life. Of course the higher the electromotive force the smaller the wire, and the lower the first cost.

It is, however, to the contractors' advantage to make everything about the installation as secure as possible, as the men are apt to neglect to adjust the brushes if they think there is a danger of receiving a nasty shock.

In the event of the cable being laid on the ground, a man might receive a fairly smart shock with 300 volts if he stood on the cable with wet boots. The shock would not hurt him, but there is the remote possibility that in springing off he might place himself in front of a train of waggons. It is advisable, therefore, either to bury the conductors or to fasten them to the roof or sides.

The fact that they might receive a shock will no doubt deter the miners from interfering with cables or machinery. They are rather a conservative lot of men, and almost every innovation meets with opposition; they have, for instance, declined to remove the coal which has been undercut by electric coal-cutting machines.

It may be as well here to inquire into some of the causes of explosions in coal mines, some of which may be laid to the charge of electricity in the near future.

It would appear impossible for tools of any kind in working coal to strike against pyrites or any hard rock without giving off sparks. The experiments, however, made at St. Etienne, in France, go to prove that this kind of spark will not fire an explosive mixture, but as an extra precaution it has been suggested that aluminium bronze containing 2 per cent. of silicon should be used for the tools, as it seems this alloy produces no sparks. There is, however, an objection to it, owing to the liability of the metals not to mix properly and so not to give the proper hardness. Spontaneous combustion is often the cause of fire, and it may be caused by oxidation of organic constituents, by iron pyrites, or by pressure. Coal, especially when in a fine state of division, absorbs oxygen, and in doing so becomes heated, and such absorption is favoured by the presence of moisture. Again it has been found that carburetted hydrogen does not become explosive until there is an excess of hydrogen present. This hydrogen can only be supplied by the moisture, therefore it is very important to ventilate the mines with as dry air as possible.

The safety lamp is only safe up to a certain velocity of the current of air, but an enclosed motor being next to absolutely enclosed, would be safe for several hours in the same current.

Blasting operations in fiery mines are always attended with danger, and a flameless explosive has yet to be invented.

Engineering and scientific precautions go for nothing if there is not at the same time constant vigilance exercised. It therefore seems to be high time that *employés* in mines were educated and made conversant with the properties of gases, with the theoretical reasons why certain precautions have to be taken in ventilating, &c. In this way we should have fewer accidents, and the colliers as a body would be a more intelligent set of men than they are at present.

Machinery.

The machines to be described are in most cases of well-known type, adapted for combination with the electric motor; and I may here remark that the handiness and ease with which the motor can be worked in combination with any kind of machinery, either by belting, gearing, or friction wheels, in any position, is one of its main features.

Whatever machinery is put into a mine must be practicable in every sense of the word, for there is perhaps no other situation where it gets so hardly dealt with. Strength and durability must come before efficiency, several breakdowns quickly producing a feeling of insecurity. The motor, therefore, must not be affected by the drip of the water in wet localities, by rapidly varying loads, or by dirt and dust; it must be unaffected by changes of temperature; it must be strong enough to withstand an occasional fall of the roof; and should be capable of going without continued attention.

It very often happens that mining machinery—as, for instance, pumps—in the event of a flooding of some part of the mine, may have to make very long runs. It is especially necessary, therefore, that all parts should be exceptionally strong, and the wearing surfaces and lubricating arrangements so arranged that there shall be no heating, the pressure in the bearings coming at right angles to the joint.

All handles for brakes reversing, starting, stopping gears, &c., should be arranged as simply as possible, so that any labourer can drive the machinery. It is usual to supply the driver with an ammeter in a convenient position, so that he can tell, say, how many trams he is hauling, and when one of them leaves the rails.

When (as is often the case in mining operations) it is necessary that the location of the machine and motor should be quickly changed, they are mounted on a trolley which can be easily moved by simply reeling up the conductors and wheeling it into the desired position.

Ropes and belting form an elastic connection between the driver and the driven, a kind of springiness which takes the jar of the armature; they take up a considerable amount of room, however, and are liable to be snapped or thrown off on a sudden accession of load. They are at a great disadvantage in wet and dirty situations owing to the rapid deterioration, and it may sometimes happen that machines have to stand in water. If belting was used in the case, say, of a winding machine when the direction of rotation is altered, the strain would be very great, and a serious accident might ensue if the belt broke.

Link belting is perhaps the best form, although it stretches a great deal. Where large powers are transmitted one belt is put over the other.

Messrs. Goolden, who have had considerable experience with mining machinery, find it best and safest to use gearing. It is certainly noisier than belting, although the improved methods of forming the teeth make them run smoother than formerly, but the machines can be put together in a much more complete form, whilst the precautions which are adopted in building up the armature effectually prevents any abrasion of the insulation from jar and vibration.

Helical wheel teeth are found to answer best, the pinion being fitted with an extra strong key but allowed to slide lengthways with the shaft, and so align itself with the gear wheels. In order to decrease the noise in small toothed pinions running at speeds of from 1,000 to 1,500, a composite structure has been adopted, the whole is built (on a bush) of alternate layers of sheet iron and vulcanised fibre, the teeth being cut by machinery.

It is usual to protect the gear wheels with iron casing, more especially where the roof is loose. These covers should, however, be capable of being quickly removed.

All the machinery should be designed so that the motor can be instantly stopped or started with full load on without unduly straining anything.

Electric Lighting.

The advantages and disadvantages of electric lighting are now fairly well known. There is no doubt that incandesent lamps are eminently suitable in mines; they do not require any trimming, are not affected by currents of air, and from their nature it is impossible for them to cause an explosion. Arc lamps, or large candle power incandescent lamps, can be used for the pit head, gear screens, &c.

To drive the machinery and lamps from the same set of mains the lamps may be arranged in series of three or four to suit the voltage. Machinery and lamps may be run from a compound or shunt wound dynamo by running separate pairs of mains, and then the one can be switched off without affecting the other. The best arrangement, however, where the plant is large, is to have the dynamos separately excited; the smaller or exciting dynamo being made large enough to

run the lamps as well. The potential of this lighting and exciting machine may be 100 or 110 volts, a separate pair of mains being run for lighting.

Of course all mines which have got the electric light or transmission of power plant installed are in a position, with a small further outlay, to adopt electric safety lamps.

FIRING EXPLOSIVES ELECTRICALLY.

The firing of fuses electrically effects a saving of time and reduces the proportion of missed shots, and therefore the cost. Any number of shots may be fired simultaneously, and this is an advantage where a considerable weight of material has to be moved.

ELECTRIC BELLS AND SIGNALLING APPARATUS.

The telephone is utilised at the La Perronière mine in France, and now that the patents have run out we shall soon hear of them being employed in a similar purpose in the United Kingdom. Electric bells are extensively used in Yorkshire and South Wales, a pair of bare wires being run along the roadways, and the circuit so arranged that when the two are put into contact anywhere the bell is rung.

The working of an electric bell by means of a manipulator in the cage commends itself at once. It would be also useful as a means of preventing very serious accidents in the event of a displacement or derailment of the cage. It could be done in several ways, one being to have a bare wire suspended to the shaft through which contact is made in case of derailment.

ELECTRIC SAFETY LAMPS.

The use of the ordinary safety lamps which give a light merely sufficient to make darkness visible, and therefore strain the eyes of the men who work with them, is becoming a matter of importance in our colliery districts, because the knowledge that the lamps in use are bad for the eyes goes far to discourage the rigid obedience to the law which compels the use of them.

The experiments conducted by Dr. Court in the Midland districts seem to show conclusively that the insufficient light given by the ordinary safety lamp is the cause of the great prevalence of eye diseases, such as nystagmus, night blindness, &c., and when we couple to this the fact that the wire gauze lamp is only safe up to a certain velocity of air, I think portable electric lamps can safely claim the following advantages :—The light-giving body is highly protected, very little heat is produced, it gives no smell or smoke, so that the air is not vitiated by noxious fumes, there is no temptation to trim the light, or to light pipes, &c., for interfering with the light-giving body would simply put it out. The lamps may be fitted with a switch, and can be lighted or put out as often as required. They can be kept in almost any position, even horizontal, for a short time without any inconvenience, and are thus very valuable for examining roofs and by giving a superior light, 1 and 2 C.P. as against the $\frac{1}{3}$ to $\frac{1}{2}$ C.P. of the old safety lamp, they enable more work to be turned out in a given time. The ordinary safety lamp has this advantage, that it shows at once if fire damp is present, and steps can then be taken to drive the gas away.

There are several types of lamps in the market.

In the Bristol electric safety lamp the battery consists of three accumulators, its weight is about 3½ lbs. (the Hepplewhite-Gray ordinary safety lamp weighs 3 lbs.), and it burns for 10 hours. The battery plates are enclosed in an ebonite cell which is again placed in a brass tube, a simple arrangement well calculated to stand rough treatment and accidental shocks. Inspection is easily made with a special key, which would not be given to the miner. They consume during charge 1 H.P. per 160 lamps, and take from 6 to 8 hours. The cost of lamps is 35s. each in quantities ; 500 would therefore cost £875, and for a 500 lamps plant complete, £921. Renewal of battery would cost 5s. about every three years. The incandescent lamps being the main source of renewals, and they will last 600 or 700 hours. Total cost of lamps per burning hour ·0905, or ·726 per day of 8 hours, and this would give about 4d. as the total cost per week per lamp.

One man is easily able to attend to 500 lamps, 250 burning at a time ; his wages would be 35s. per week. Allowing for depreciation, the yearly cost of a 500-lamp plant complete would be £568 6s. 4d., or rather more than 20s. per lamp.

HAULING AND WINDING MACHINES.

It appears from the returns that, as a rule, the deepest mines are the most productive, therefore long haulage roads are becoming more common every year. A good proportion of the roads having gradients which will not admit of the locomotive they have to be worked by wire rope haulage, the hauling machine being erected in some central position underground. There are several systems of haulage—continuous rope, main and tail rope, and single rope.

In the continuous rope hauling machine the electric motor drives by means of belting or gearing one or more clip pulleys, which keep in motion the endless wire rope to which the tubs may be hitched, and so dragged in and out of the mine at any time.

The main and tail rope hauling machine has two drums bushed with gun metal, and they revolve loose on the shaft. A clutch between them enables either drum to be driven at will. The machine must be made strong enough to pull all the loaded tubs of the mine at one time, and it thus has to stand for considerable intervals, whilst the tubs are being filled.

The single rope hauling machine being used for drawing tubs up a steep incline, it is fitted with only one drum, as the tubs run down again of themselves, being kept in check by the brake.

Portable hauling machines are intended to save the work of horses. It is fitted with trolley wheels, and so can be moved about as required ; it can be taken to the top of the incline and there scotched up, temporarily working as a fixed single rope machine ; or it will work itself into position by winding up the rope, as it climbs the incline, the current being supplied through an easily handled light twin wire.

Messrs. Goolden have recently supplied geared continuous hauling machines, which were intended to draw four loaded tubs up an incline averaging 9 inches per yard. In the trial eight loaded tubs were put on a part of the incline which was 16 inches per yard, the motor was then suddenly started and stopped several times without mishap, where belting would as likely as not have been thrown off.

In an electric windlass, made by Messrs. Ganz & Co., the winding drum is driven through the worm and worm wheel. This machine was built for the purpose of raising earth in the sinking of a shaft. It is fitted with a series of resistances and an automatic arrangement, which can be easily adjusted, so that as soon as the load has arrived at a certain height, successive resistances are put in, and the current finally interrupted, a brake being thrown in gear at the same time. Unless the pitch of the worm is very steep, the cage will not run down even if the connection with the motor is broken.

PUMPS.

The safety of a mine very often depends on the efficient and prompt dealing with a sudden influx of water into the workings, and what is wanted in that case is a pump that can be quickly got to work on the spot.

The mode of dealing with the large quantities of water often met with in sinking pit shafts is also an important matter. If Cornish pumps are used, the continuous lengthening of heavy spear rods is an objection, and if the modern power pump is placed at the bottom there is a difficulty in finding room to carry on the sinking operations. Perhaps the best way, and one to which electrical transmission lends itself beautifully, is to suspend the pumps (fitted with telescope suction) in the shaft by means of stout wire cables attached to capstans on the surface, the machine being steadied temporarily by props. Several pumps are at work suspended like this, and doing very well.

With electric pumps the three throw crank is generally adopted, because the stress on the motor should be as regular as possible. The motor runs at about 550 revolutions per minute ; the speed being reduced through one or two sets of helical toothed gearing.

VENTILATING FANS.

The atmospheric condition of a mine is one of primary importance, and anything which will give a better ventilation than at present in vogue in some collieries should be welcomed, as there can be no doubt that the furnace system of ventilation increases the danger of fire, and makes it almost impossible to ascend or descend by the up-cast shaft in case of an accident.

With ventilating fans, as with rotary pumps, electric motors are especially suitable, since the high speed required enables them to be coupled direct. The locations of fans, too, are often such that a pair of copper cables can be very cheaply and easily laid down where piping would not go.

The advantages claimed by using the exhaust of compressed air motors for ventilation is questionable, and could be done in a more efficient manner by means of a system of electrically driven fans, or by putting down a separate steam engine and piping.

It might be interesting to note the Blackman fan patented by Mr. Watel. The fan and motor are combined to form one piece of mechanism, a multipolar motor, in fact, with an armature of very large diameter and small cross section. The armature is carried at the periphery of the fan, the field magnets being in a circle round it. The commutator is on the spindle, and the end of the armature windings are brought to contiguous sections, alternate sections being in electrical contact, so that the current is reversed through the armature the moment the poles come together, when the pole on the armature is attracted by the next pole of the field magnet, and so on, to produce rotation. The magnets are shunt wound. Those fans would no doubt be found useful in ventilating side passages.

DRILLS.

Several electric rotary drills have been made. In drills, we want strength combined with lightness, so that one man can handle it, and this cannot very well be got by attaching the motor direct on to the drill spindle. It is usual, therefore, to mount the drill on a separate trolley, and drive through a flexible shaft, or an endless band and grooved pulleys. The Ingersoll percussion machine, in which the drill is impressed forward by a powerful volute spring, lends itself very well to being driven in this way.

For hard rock, however, the machine which gives most promise is that in which the energy is given to the reciprocating drill spindle by a current flowing alternately through a pair of solenoids or coils of wire, thus alternately attracting and repelling the mass of soft iron attached to the drill spindle.

The Van Depoele percussion drill has three coils or solenoids, the outer ones consisting of a few turns of thick wire, and the inner, which has the chief magnetising effect, of many turns of thin wire.

The continuous current dynamo has a fixed pair and a rotating pair of brushes, and will therefore give continuous, alternating, or pulsating currents, depending on how the brushes are coupled up. The outer coils are connected to the rotating brushes, and are therefore traversed by alternating currents. The polarities of these coils will, of course, change with every alternation.

The inner coil is traversed by pulsating currents, which are got by connecting to a fixed and to one of the rotating brushes. The polarity of the coil, iron cover and casing, is always the same; it rises and falls with the current.

It is evident that at certain points the outer coils will have ceased to attract the core. On each side of that point, however, they begin to exhibit polarity, and the iron core is moved backwards or forwards, as the case may be.

The core and drill is brought to a standstill at each end by the three similar poles coming together, that is, the poles of the iron casing, the core, and the coil; they repel, and the drill is started off in the opposite direction. The drill shown at the Frankfort Exhibition struck 325 blows per minute. The moving parts are only the iron rod, to which the drill is attached, and a turning arrangement at the back to move the drill round part of a revolution at each stroke.

(To be continued.)

Electricity and Chemistry.—La Société Industrielle, of Rouen, are offering a gold medal for a new application of electro-dynamic machines in practical chemistry. The awards will be made in February, 1893, but the last date for the receipt of competitions, which should be addressed to the President, La Société Industrielle de Rouen, Place Haute-Vieille-Tour, 24, is September 2nd next.

THE FIVE-WIRE SYSTEM OF DISTRIBUTION AT PARIS.*

THERE is a marked difference between the American and the European central station practice, both as to the types of machines in use, and the methods of distribution and regulation employed. In this country, although experimenting is carried on to a large extent by most of the electrical manufacturing concerns, there is a noticeable tendency to adopt as a "standard" a machine or arrangement which has been found to be practical, while on the other hand there is no "standard practice" to be found in Europe, and almost every succeeding installation is marked by considerable change of detail. In other words, the American plan seems to be to put the business on a commercial basis as soon as possible, and to adhere to the practice first adopted, while abroad this work has been the object of experiment to such an extent that it is rare to find any two stations similarly equipped.

The central station recently built in Paris by the Société Anonyme D'Elairage Electrique is sufficiently different from what we are accustomed to see in this country to illustrate this fact.

The engine and dynamo room contains three engines of the Corliss type, directly connected to three continuous current dynamos, and also three Armington and Sims cross-compound engines, each of which is belted to two direct current generators.

The Corliss engines have a capacity of 500 horse-power each, with an initial boiler pressure of 7 atmospheres. The flywheel is 19 feet in diameter, and weighs about 9,000 pounds.

The generators are of a multipolar type, manufactured by Siemens and Halske. They have a capacity of 375 kilowatts (750 amperes at 500 volts) when run at a speed of 65 revolutions per minute.

The Armington and Sims engines each develop 150 horse-power, running at 250 revolutions per minute, and the small dynamos have a capacity of 50 kilowatts (200 amperes at 250 volts) at 500 revolutions.

This plant is the central station from which several substations are supplied. The connections to these distributing stations are on the two-wire system, but the distribution for services is on the five-wire system. There are nearly 100 miles of cable underground which supplies electric light and power over a large area in the city. There are now about 20,000 incandescent lamps, 500 10-ampère arc lamps, and a number of motors of 6 horse-power and under which are operated from this station.

A large accumulator plant is soon to be added to the already large installation now in use. These will consist of Tudor batteries of 2,000 ampère hours capacity, and which will be capable of discharging at the rate of 600 amperes, if necessary.

The present battery plant is divided into two groups of 250 cells each. These cells are of the Laurent Cely Sarcia type, and have given very good results. The proper potential is maintained by means of an automatic device which cuts a number of cells in or out of the circuit as desired.

As the normal electromotive force of 250 cells is about 500 volts in discharging, it is necessary, in order to fully charge them, to use a current of higher potential, for the reason that the voltage obtained in discharging a battery is somewhat less than the voltage it requires for charging.

To obtain this increase in the potential of the charging current, a constant current transformer is used which gives a current of 110 volts pressure. This transformed current is connected in series with the 500-volt circuit whose pressure is thus raised to 610 volts.

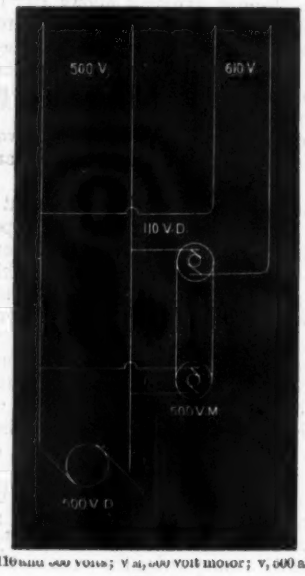
This is shown diagrammatically in fig. 1, which will, perhaps, explain the system more clearly.

The 500-volt dynamo represents the station generators to which a 500-volt motor is connected. This motor drives a dynamo which supplies a current of 110 volts. One of the brushes of this dynamo is connected to the 500-volt circuit, which is practically putting the two machines in series. This, of course, has the effect of adding the voltages of the two dynamos, which in this case gives a potential of 610 volts available for charging the batteries.

* New York *Electricity*.

In practice, the motor and the generator which it drives are combined in one machine, their armatures being wound on one shaft.

The use of the five-wire system gives unusual flexibility and range as to the class of services which may be supplied from the station. By reference to the diagram fig. 2, it will be seen that the five wires have a difference of potential between each of them of 110 volts, and services may be taken



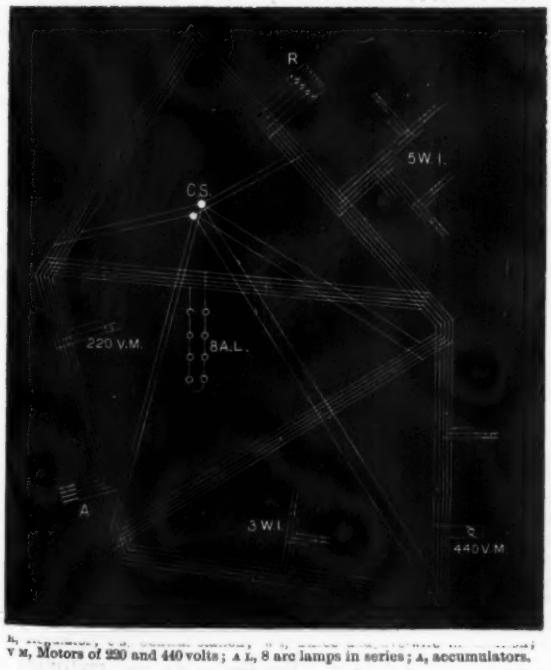
V D, Dynamos of 110 and 500 volts; V M, 500 volt motor; V, 500 and 610 volt circuits.

FIG. 1.

from any two of them according to the voltage desired; 110, 220, 330 or 440 volts being available. It will be seen that the feeders from the station are on the two-wire system, and are connected to the two outside lines only.

A drop of 12 per cent. is allowed in the feeders, leaving a maximum pressure of 440 volts at the mains.

As with the three-wire system, which is largely used in this country in central station distribution, the necessity for



V M, Motors of 220 and 440 volts; 8 A L, 8 arc lamps in series; A, accumulators.

FIG. 2.

preserving a balance of load between all the different wires of the system, is of the utmost importance. In other words, the amount of current delivered from each adjacent pair of mains should be equal. If this condition is not observed there will be a drop in the potential of the circuit carrying the greatest load.

The balance of load is, as far as possible, maintained by taking off services from the mains in such a way as to leave an equal load on each circuit. In the case of large lighting installations, the five-wire system is continued through the house wiring. Large motors and other services requiring considerable power are taken from the outside lines, which does not affect the balance in the mains, and small services are distributed evenly between the different inside wires.

It is evident that some difference of load will always exist however carefully the services are distributed, and to adjust this difference a regulator is used, the connections of which are shown in fig. 2. This consists of four machines combined in one, the four armatures being rigidly connected to one shaft, and each of them embraced by a separate pair of fields. The four machines are exactly alike, and their field windings are connected in series, forming a shunt across the outside mains.

In the case of the load being divided between the five wires in four equal parts, the current and the voltage on each of the four circuits will be equal, and the motors composing the regulator will run without load, and each of them will develop the same counter electromotive force. If, now, the balance be destroyed between any of the circuits, the potential of the circuits having the greatest load will be lowest, while the pressure of the circuits with least load will be highest. As the armatures of the different machines must revolve at the same speed, their counter electromotive forces will be the same. Now if one circuit, for example, drops in pressure to 100 volts, the armature in that circuit will drag on the other three armatures, and throw a load on them. In this way the three armatures in the high circuits will divide between them the excess of load in the low one, thus equalising the pressures and the load throughout the whole system.

This regulator, which is said to equalise the system with great accuracy, is simply a modification of the compensator, which has been used for several years in connection with the three-wire system in this country.

The machinery in this station is shut down during the hours of light load, and the system is then regulated by accumulator plants, situated at the sub-stations, which are at the feeder terminals shown in the diagram.

These regulating batteries are connected in four groups of 52 cells each; each group being connected to one of the 110-volt circuits. These batteries acting simply as regulators, do not discharge unless the potential of the circuit to which they are connected falls below the normal. In practice they are never wholly discharged.

The manner of taking off different services to preserve the balance in the system and the methods of feeding, regulation, &c., are explained graphically in the diagram, and are sufficiently unique to merit careful attention.

[This installation was described in great detail in the issues of the REVIEW of March 6th, May 15th and June 5th of last year, but we have thought the diagrams and later information here reproduced would be interesting to our readers.—EDS. ELEC. REV.]

ECONOMY IN ARC LIGHT WIRING.*

BY W. B. ROMMEL.

I HAVE noted with interest the suggestions made by Mr. Sharpsteen on arc light wiring in the *Electrical Engineer* of March 16th, and fully appreciate the necessity of economy in this direction. From time to time we hear of many plans for reducing the amount of copper on our incandescent circuits, but the question of reduction on arc circuits seems to have been sadly neglected by our electrical engineers. While economy in the former instance is no doubt the most desirable, we still find a large field for improvement in the latter, which means less capital to the investor, and a corresponding reduction in the amount of line repairs.

The plan used by Mr. Sharpsteen would be of value in but very few instances as, in order to effect any saving in wire, both municipal and commercial lights must be located on, or very near, the same street. In the majority of cases, however, it is found necessary to string one line through

* *Electrical Engineer*, New York; see also ELECTRICAL REVIEW of last week.

one street and return by another. This would necessarily cause a constant return of the line to either street in order to keep the commercials in rotation, and would consume more wire, and require more poles, in many instances, than by running an entirely separate circuit.

The objection to wasting power, caused by starting municipal lights at the same time as commercials, raised by Mr. Sharpsteen, is to the majority of electric light superintendents the least consideration, as on nearly all circuits single-carbon lamps are used for commercial lighting, and in many cases the consumer neglects to turn out his lamp when business hours are over and at the time contracted for. The lamp then, on burning to the full length of the carbon, cuts itself out automatically, but still has the full current travelling through its magnet coils; and this is not only detrimental to the adjustment of the lamp, but to the life of the coils themselves. Here we have another and greater loss of power caused by the lamp burning from the contract time to the point of cut-out, as well as materially injuring the mechanism; and in order to obviate these difficulties it is absolutely necessary to control our commercial lamps from the station. I have made it a point, of recent years, to place a short-circuiting switch in addition to the ordinary cut-out within easy reach, and the result has been more than encouraging; the switches saving over and over again their original cost in power and life of lamp.

To my mind the advancement of economy in arc wiring lies more in the direction of a single circuit from which all commercial and municipal lamps can be turned off and on by an automatic cut-out operated by battery from the station. This automatic cut-out will take the place of the ordinary cut-out, and the amount of wire necessary to operate them will be a comparatively small item. We find just such an automatic switch employed for incandescent work, and illustrated in the same issue of the *Electrical Engineer*; and it is but a question of a short time when this plan will be adopted for arc circuits, thus materially reducing the consumption of copper by local electric light companies.

By C. G. YOUNG.

The article by Mr. S. H. Sharpsteen in the *Electrical Engineer* of March 16th, 1892, will no doubt be favourably received by the superintendents of arc light plants, and while there has been but little said of the economy in wiring, as practised in such plants, still there has been advancement made in the saving of wire and circuits in some of the recent arc light plants installed, and for the benefit of the large majority of central stations it is hoped that others will contribute information, and bring up the standard of economy in arc light wiring to a favourable comparison with the best practices known, for the distribution of power and incandescent lighting on the constant potential systems.

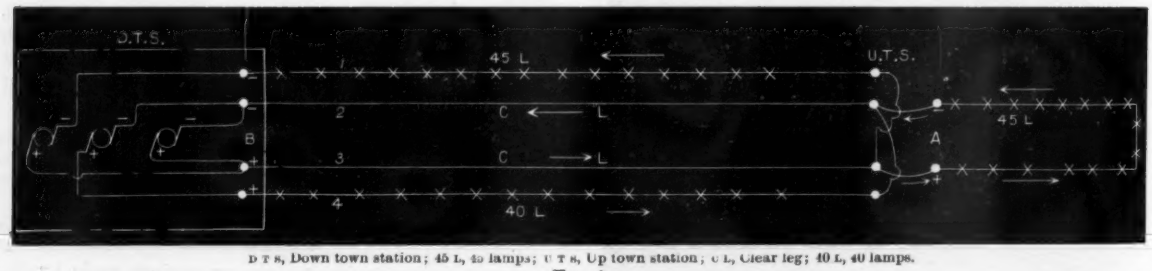
It would be interesting to determine the exact saving as shown in the scheme proposed by Mr. Sharpsteen; for if there happened to be more commercial than city lamps on the 3-legged circuit, the extra cost of the third leg might be more than the saving of coal effected by starting the city lights later than the commercial. However, the idea of the third leg is of value, and can be used to great advantage in many cases.

There are many disadvantages in running the dynamos in series, and therefore, where a circuit has as many as 100 arc lamps connected and the dynamos are of 50 lights capacity, a third leg connecting the middle point in the circuit and running back to the station and used as a common return wire for the two 50-light dynamos, allows city lights to be connected on one positive leg, and the commercial lights to be connected on the other positive leg, and they can therefore be started and stopped independently of each other; or all lamps to be operated until midnight may be connected on one positive leg, and the "all-night" lights connected on the other positive leg, and thus two arc circuits can be operated independently of each other and with but three wires.

I may instance a case where this idea was put to good use in New York City, where a company is operating two stations, one down-town and the other up-town, the two stations being connected by a trunk line which operates some of the up-town station circuits from the down-town station, and also commercial lights between the two stations. The remaining circuits were operated from the up-town station. On account of the pressure of business the writer designed the scheme shown in fig. 1, which allowed of the operation of three dynamos on two circuits, each dynamo being independent, and entailed no increase in voltage, as would have been the case were the dynamos connected in series.

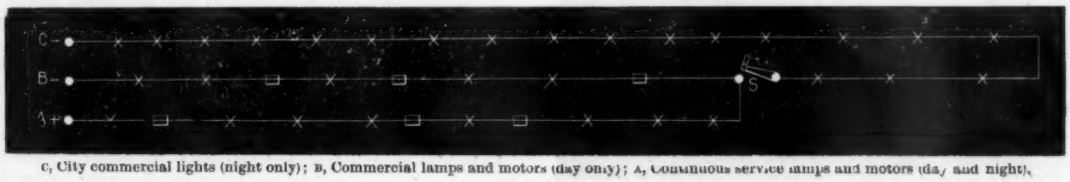
This arrangement allowed of the saving of two wires between station B and station A, a distance of six miles, *i.e.*, 12 miles of wire. Of course, it will be readily understood that the legs 2 and 3 carry twice the current of legs 1 and 4, being required to take the current of lamps emanating from station A, in addition to the current for the lamps in legs 1 and 4. The actual current in 2 and 3 was 20 ampères, the normal current being 10 ampères. The wire was No. 6 B. & S., and proved quite ample for this purpose.

Another case where the 3-legged circuit was adopted, was for the operation of (1) a continuous day and night circuit, (2) a day circuit only, and (3) a city night circuit, all three services carried out with the use of but three wires. As shown in fig. 2, all of the day service was connected in the leg marked B, all the continuous service customers requiring current 24 hours daily connected in leg marked A, and city lights and night service customers connected in leg marked C, one dynamo only being employed. During the day the dynamo was connected with A and B, and at 6 p.m., the dynamo cable was transferred from B to C, and again in the morning replaced in B. For the safety and protection of the day trimmers, a switch was placed at S, which was required to be disconnected in the morning before trimming, and again thrown on after all the lamps were trimmed. In this case the amount of wire saved is equivalent to three conductors equal in length to the distance between B and S. This system of circuits, though now discontinued, was found flexible and economical, and if well managed is simple and safe.



D T S, Down town station; 45 L, 45 lamps; U T S, Up town station; C L, Clear leg; 40 L, 40 lamps.

Fig. 1.



C, City commercial lights (night only); B, Commercial lamps and motors (day only); A, Continuous service lamps and motors (day and night).

Fig. 2.

The following correspondence on the same subject also appeared in the columns of the New York *Electrical Engineer*:—

"The interesting paper under the above caption, by Mr. Sharpsteen, in your issue of March 16th, suggests to us the propriety of referring to the method by which this company accomplishes the same object, viz., the simplification of circuits, and consequent saving of initial capital, as well as subsequent maintenance.

"We have endeavoured to approach this subject in the spirit of engineers, not of mere salesmen. The operating electric light companies, both in the larger cities and smaller towns, seemed to us to be between the horns of a dilemma; either they had to run separate circuits for each class of lights, or else burn the short-term lights until those of the longest term were cut out. Both methods were wasteful, and it was only a question as to which would cost the more in the long run.

"To meet the contingency, we applied our principle of 'Individual Selection,' and worked out a system of 'Individual Cut-outs,' by means of which any loop of lights or motors on a given circuit could be cut out or in at any time from the central station without affecting others on the same lines. Adapting this plan to the case cited by Mr. Sharpsteen, we would dispense with the third wire of a larger capacity, and run a No. 12 wire on which the locks and cut-outs would be placed. The commercial and city lamps would be put on the same circuit; the former grouped into convenient classes, say 9 o'clock, 10 o'clock and midnight, or any other arrangement called for by contract requirements. One of our combined locks and cut-outs would be placed in each loop, and each set of lights cut out at its contract hour by the central station operator using the transmitter provided for that purpose. This would leave the city lights burning alone when the last commercial lamps were extinguished, and allow the commercial lights to be started an hour or two earlier than the city lamps, as is necessary in most cases, and thus effect a saving of current. In the same manner, each loop would be cut in again when its hour arrived. If it should happen that the lights of one class were so separated that they could not be advantageously brought into one group, they could be divided into sub-loops, and a switch (as distinguished from the combined lock and cut-out) be introduced in each one. In this case the one lock would work all the switches on its own loop together. The extra expense would be confined to a slightly greater length of No. 12 wire, which is the size used in connecting up our locks and switches, all of which are operated with a single line.

"If a comparison be made between this system and the method of wiring usually adopted, ours will be found to possess some very positive advantages, both on the score of economy and otherwise. Those who have been forced, by unsympathetic municipal authorities, to go underground with their wires, will find that they can save many a mile of costly feeders, while those to whom the air is yet free, are enabled to run a single feeder to distant points of distribution, and there divide their circuit into loops controlled at pleasure from the central station. Many modifications of this use are feasible, for our object has been to furnish a system elastic enough to be of general utility. The vital feature is that the power of selection is placed with the central station, and its control of individual lamps, motors or groups made absolute, irrespective of distance or variety of class.

"Our conviction that we are giving electrical engineers, as well as light and power companies, an effective means of simplifying and consolidating their services, is our excuse for encroaching upon your space, and at the same time showing as marked an advance over the plan suggested by Mr. Sharpsteen as is his over the well-known metallic system for the control of each bank of lights.

"Electric Secret Service Company,
"By C. P. Mackie, *General Manager*.
"New York City."

This letter, says our contemporary, would seem to show that arc lighting practice is still far from that condition which incandescent work has attained where economy in wire is concerned. The methods for securing a saving of circuit as shown by Mr. Sharpsteen and by Messrs. Young and Mackie, are based on different principles, and are well calculated to constitute a good basis of comparison for arc light station managers. A suggestive discussion of the subject is also furnished by Mr. Rommel, a practical central station manager. Now that prices for street lights are cut down so near the point of unprofitableness, these methods of economising in circuit construction, or in operating expense, become more and more worthy of attention.

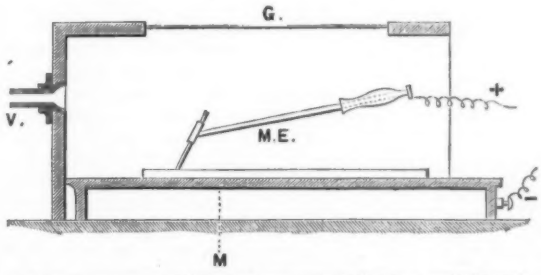
ELECTRIC ARC WELDING INVENTED BY DE MERITENS IN 1881.

By A. M. TANNER.

A United States patent issued to Auguste De Méritens on the 22nd day of March, 1892, No. 471,242, is for electrically welding metals in the manner usually considered as having been invented by Benardos in the year 1885.

It appears, however, that De Méritens obtained a French patent on the 24th day of November, 1881, No. 146,010, for the invention set forth in this recently issued American patent; under the United States patent laws and by virtue of said French patent, De Méritens was able to prove priority of invention over Benardos and obtain a patent with the fundamental claims quoted below, viz.: 1. The herein described art or process of joining two pieces of metal together by a welding or soldering operation, consisting in forming an electric arc at those points only of the metal which are to be joined, the heating current being adjusted at said point to the required welding or soldering temperature. 2. The herein described process of joining metals by means of the directly applied electric current which consists in forming the voltaic arc along the desired line of junction by a conductor forming one pole, while the metal forms the opposite pole in proximity to the first.

The sketch below with explanatory notes, will show the construction of the apparatus used by De Méritens.



o, glass; v, vapour escape tube; m e, movable electrode; m, metallic work support and electrode.

The same drawing is also found in the published French patent, which strangely enough, has never been referred to in connection with the Benardos or so-called Russian process, which did not make its appearance until the year 1885.

It may be stated that De Méritens practically used his process in 1881, for welding secondary battery plates, and thus he should be considered as having first proposed the industrial welding of metals by means of the voltaic arc.

The Electrolytic Separation of Mercury from Copper.—The separation of mercury from copper by electrolysis was attempted some three years ago by E. F. Smith, whose work in this direction we have frequently noticed, but it was not found to be complete unless the amount of copper present in solution did not amount to more than 20 per cent. of the mercury. He has, however, returned to the question and with the assistance of A. W. McCauley, has found (*vide Berichte*, xxiv., pp. 2,936—2,938) that by carefully regulating the current it is not only possible to separate the two metals when present in equal quantities, but also even when there is twice as much copper present as mercury. A table given shows the results obtained.

NOTES.

London Electric Railway Schemes.—The Joint Committee of both Houses, to whom will be referred all the schemes now before Parliament for the construction or extension of new or existing electric and cable railways within the limits of the metropolis, will consist of the following members: Earl Lauderdale, Earl Strafford, Viscount Barrington, Lord Thring, and Lord Kelvin, representing the House of Lords. The following members will represent the House of Commons: Mr. T. H. Bolton, Mr. J. S. Gathorne Hardy, Mr. Story-Maskelyne, Mr. Stansfield, and Mr. Whitmore.

Electric Lighting in the Midlands.—The Burton-on-Trent Corporation, which at present owns the gasworks of the borough, have determined, says the *Financial Times*, to lay down an electric light plant for the public supply of electricity under the Electric Lighting Acts, in connection with which the streets will also be electrically lighted. The contract has been adjudged to Hammond & Co., of 117, Bishopsgate Street Within, London. The same firm has also been appointed the engineers for the erection of similar works to be carried out at Leeds under a recent Provisional Order.

Electric Launches.—The *Bonnie Southport*, an electric launch, had her trial trip on Tuesday last week, and on that occasion gave very satisfactory results. This handsome boat was designed and moulded by Mr. W. S. Sargeant. The accumulators on board, each containing 19 plates, with a capacity of 140 ampère hours, were supplied by the Electrical Power Storage Company. The propellor was one of Mr. Sergeant's latest type, designed for high speed and for electrical power.

Heating Secondary Batteries.—The idea of heating secondary batteries during charging, says *Industries*, is being revived. Some suggestions of this sort were made in a patent of Brush's in 1882. This specification is a sort of treatise on the subject. It used to cost some 4s., but as all specifications are now reduced to 8d., it may be worth while to send for Brush's specification No. 3,108 of 1882.

Measurement of High Temperatures.—Prof. W. C. Roberts-Austen, in a lecture delivered at the Royal Institution, recently drew attention to the reliable results which could be obtained in measuring high temperatures by means of a thermo-couple formed by twisting together the ends of two wires, one of platinum and the other of a platinum rhodium alloy containing 10 per cent. of the latter metal. An accuracy of 1° in 1,000° could be obtained. For temperatures above 1,000° wires of iridium and iridium alloyed with 10 per cent. of platinum could be used as a thermo-couple up to 2,000°. The apparatus, which simply consists of a thermo-couple in circuit with a D'Arsonval galvanometer, is calibrated by placing the couple in some material whose melting point is known and noting the deflection obtained. Many interesting results with reference to the phenomenon of recalescence were obtained.

Electric Lighting Subways.—The Chancellor of the Diocese of London had before him last week an application to allow the City of London Electric Lighting Company to make a subway under two City churchyards. Dr. Tristram granted the application of the company on condition that certain small sums should be annually contributed to the maintenance of the churches and churchyards of St. Bene't Sherehog and St. Nicholas Acons.

Telegraph Facilities to the East.—A Reuter's telegram from Shanghai, on April 7th, states that the negotiations which have been recently carried on between the Chinese Government and the Eastern Extension and Great Northern Telegraph Companies have now been brought to a successful termination, and an equitable arrangement has been arrived at, which contemplates a reduction in the tariffs and other telegraph facilities, which will be beneficial to international commerce. The arrangement which has been come to between the Chinese representative and the two great telegraph companies has now been submitted to the Imperial Government for its consideration, and there is every reason to believe that it will be ratified.

Electric Lighting in Glasgow.—We hear that the Glasgow Watching and Lighting Committee has decided to ask the Electrical Committee for an offer to light the centre of the city.

Cork Literary and Scientific Society.—At a meeting of the Council, held on 7th inst., the Percival silver medal for the best paper on the "Applications of Electricity in Ireland," was awarded to Mr. S. Plummer, of the Engineering Branch, Postal Telegraphs.

Electric Lighting at Newbury.—Messrs. Plenty & Co., mechanical engineers, of Newbury, are about to light their foundry by means of electricity, which is to be generated on the premises.

Telephones in India.—According to the report of the Bengal Telephone Company for last year, the profit in that period amounted to 54,676 rupees, a dividend of 5½ per cent. being declared.

Electric Lighting at Huddersfield.—Last week, at the Borough Offices, Huddersfield, Mr. Rienzi Walton, M. Inst. C.E., held an inquiry relative to an application by the Huddersfield County Council for sanction to borrow £50,000 for electric lighting purposes. The Town Clerk stated that on April 6th last year the County Council applied to the Local Government Board for sanction to borrow. The Board of Trade issued two electric lighting orders for the borough in 1890, the second in August of that year, and by that order it was provided that the council should commence the works in the compulsory area within two years of that date. Mr. A. B. Mountain, the electrical engineer, produced plans of the generating house, which will be in St. Andrew's Road. There would be provision for 6,660 8-candle light incandescent lamps. There would be three dynamos on the Brush principle. This was all the evidence which was offered. There was no opposition. The corporation have made arrangements to lease some land in St. Andrew's Road for 999 years at a yearly rental.

Submarine Cable to Japan.—It is reported that the Japanese Government have promised a subsidy towards the construction of a proposed new submarine cable between British Columbia and Japan.

Telephonic Communication in Norway.—It is proposed to construct a telephone line between Christiania and Bergen, in Norway, a distance of about 315 miles.

The Electric Light in Germany.—The theatre in the town of Weimar, in Saxe-Weimar, is being installed with the electric light. The central station, which is being constructed by Messrs. Siemens & Halske, will be capable of supplying current to neighbouring premises in addition to the theatre.

The Electric Light in Madrid.—It has been decided not to put down a special generating plant for the electric lighting of the Spanish House of Parliament in Madrid, but the necessary current will probably be taken from the mains of the German Electric Supply Company. Messrs. Levi and Kocherthaler have secured the contract for the installation in the "House."

Electricity in South Africa.—It is proposed to utilise water-power near the Table mountain, about 3½ miles from Cape Town, in the generation of electricity to be used for the illumination of the town, as also for the motive power of the tramways. It is also proposed to utilise the Hardeck waterfalls for electrical purposes in Maritzburg, Natal, a distance of over 12 miles.

The Chicago Exhibition.—The negotiations of Messrs. Siemens and Halske, of Berlin, with reference to a large exhibit at the Chicago Exhibition are said to have fallen through, owing to some difficulties with the Exhibition authorities.

St. James's and Pall Mall Electric Light Company, Limited.—The electricity supplied by the St. James's and Pall Mall Electric Light Company, Limited, during the quarter ending March 31st last, is valued at £10,024, as against £9,652 for the corresponding period of last year.

Swansea Electric Lighting.—We hear that a prominent Swansea Town Councillor has suggested that the Alexandra Road and High Street be lighted with electricity generated from the lighting station at the Arcade, and Mr. J. C. Howell, the electrician, who is in charge of the Arcade lighting arrangements, considers the scheme perfectly feasible. The matter will, it is understood, be discussed at the next meeting of the Town Council.

Fire.—A most disastrous fire occurred on Sunday last destroying the premises of Messrs. Davis and Timmins, at Charles Street, Hatton Garden. Particulars of the arrangements made by the firm will be found among our business notices.

Newspapers and the Boat Race.—The celerity of telegraphic communication was well exemplified at the University Boat Race on Saturday. The Press boat, as it sailed up the Thames, paid out a cable over the whole length of the course, and at each important part of the race a telegraphic message was despatched by the Press Association. The result was that within a minute of the boats passing any well-known landmark, the clubs in London were informed of their positions. Furthermore, papers were to be bought in Trafalgar Square giving full details of the race at 12.41, within six minutes of the arrival of the Oxford crew at the winning post.

The Lauffen-Frankfort Transmission.—A correspondent of the *Times* has received a telegram from the President of the late Frankfort Exhibition as follows:—"Official report of testing committee gives mean efficiency in Frankfort at full load 74 per cent., where loss of energy in dynamo, 8 to 10 per cent., included; from this results for transmission proper to secondary transformer at the exhibition a mean efficiency of from 80 to 82 per cent."

Electrical Engineering Appointments.—Mr. James Davidson, of the Glasgow G.P.O. Telegraph Department, has been selected by the Anglo-American Telegraph Company to be second electrician on board their submarine telegraph cable repairing steamer *Minia*, on the promotion of Mr. Maynard Dodd to chief electrician. This is the third electrician in succession which the Anglo-American Telegraph Company have selected from Prof. Jamieson's best electrical engineering students at the Glasgow and West of Scotland Technical College. Mr. W. H. F. Murdoch, at present assistant to Prof. Jamieson in the day class electrical testing department, has been chosen by Messrs. Siemens Brothers to join their London staff at the end of the session.

Delay of a Cable Ship.—The Anglo-American Telegraph Company's steamship *Minia*, from London to Halifax, which put in at Plymouth to coal, and proceeded on her voyage on Thursday last week, put back to Plymouth on Sunday, smallpox having broken out on board.

A Large Electric Locomotive.—A very large locomotive is now being built at the works of Messrs. Brown, Boveri and Co., at Baden, Switzerland. This engine, says a German contemporary, will be fitted with dynamos of a total of 1,500 H.P., but which could be increased up to 2,000 H.P. The power will be transmitted to eight electro-motors, arranged on the same number of axles. It is said that this locomotive will attain a higher speed than is usual with steam locomotives, and trials of its capabilities are to be made at the end of the summer.

Oil as an Insulator.—Our contemporary, the *Electrical World*, commenting upon Prof. Hughes's paper before the Institution of Electrical Engineers, says:—"Hughes, who, by the way, we can claim as an American though now in London, now receives the glory as the first inventor, while Brooks received the shekels for the invention." Will Prof. Hughes admit the claim?

Bradford Electric Lighting.—Reduction in Price.—At the monthly meeting of the Bradford Town Council, held on Tuesday last, the Gas and Electricity Supply Committee recommended a reduction in the price charged for electricity from 6d. to 5d. per unit, the reduction dating from the 1st inst.

Personal.—A ceremony of a very interesting character took place a few evenings ago at Cadiz, the occasion being the presentation to Mr. Charles Wilson, late superintendent of this station of the Spanish National Submarine Telegraph Company, Limited, of a handsome gold watch and chain, and to his wife of an exquisite gold bracelet. The watch bore the following inscription: "Presented to Mr. C. Wilson by the members of the Victoria Club and friends on his leaving Cadiz, March, 1892." The presentation was made at the club rooms before a goodly assembly of the English colony, and hearty good wishes were expressed for the future prosperity of Mr. Wilson in his new appointment as superintendent of the South American Cable Company's station at Pernambuco.

We hear that Mr. Emile Garcke, formerly managing director of the Brush Electrical Engineering Company, Limited, has been appointed managing director of the Electric and General Investment Company, Limited.

Choking Coils.—Though transformers have been studied at great length, says *Industries*, the simpler case of choking coils has not received much attention. Prof. Perry read a paper on the subject at the Physical Society recently, but he dealt chiefly with the loss by hysteresis and Foucault currents in the core. He seems to have over-estimated the loss of power by Foucault currents. Really, the design of a choking coil is a very simple matter. As our contemporary had previously pointed out, a choking coil must in practice have an open iron circuit. The loss in iron and the effects of Foucault currents have then no appreciable influence on the current. Prof. Perry does not seem to have realised this at all, and has apparently considered the case of a choking coil made like a closed circuit transformer with only one winding. It is a great pity that theory and practice are so widely separated in transformer work. At present makers continue designing transformers according to their own lights, and people who do not make transformers write papers which are useless because the authors have no idea of the relative values of the quantities with which they deal. If makers and writers of papers could only get into touch they might help one another. At present they might as well be discussing different subjects in different languages.

Oil Insulation.—Professor Ayrton pointed out at the Institution of Electrical Engineers, a few weeks ago, that there are three kinds of insulation to be considered. Oil was proposed, says *Industries*, and we presume used at a very early date for insulating Ruhmkorff coils. Dr. Fleming has unearthed several early instances of this. Here two important properties come into play—dielectric strength, and healing after the accidental passage of a spark. This healing property is of no importance in electric light work, because, if there is available power behind, the oil is carbonised, and the copper is fused, and there is a general wreck. In fact, in this respect, a Brooks line may even be dangerous. Suppose an arc occurs; it will evolve gas, and great pressure will be produced in the interior of the pipe. If the pipe is long, the oil cannot get away, and the pipe will be burst. In the case of a wrought-iron pipe this would be like bursting a small cannon in the street, and might lead to a serious accident. Our contemporary does not care to go into the history of the invention. Oil insulation has been invented, and the next thing is to make the best we can of it. If it is destined to take the place of rubber and gutta-percha, it will save the electrical industry many thousands of pounds, and no subject deserves greater attention just now than that of electric cables.

Budget Telegraph Returns.—In the figures placed before Parliament on Monday last, Mr. Goschen stated that the Post Office and Telegraphs had yielded a gross revenue of £12,630,000.

NEW COMPANY REGISTERED.

Corlett Electrical Engineering Company, Limited.—Capital, £10,000 in £10 shares. Objects: To acquire the goodwill of the business of electrical engineer carried on by Mr. George S. Corlett at Wigan and Bolton, in the County of Lancaster; to carry on the business of an electric light company in all its branches; and to carry on the business of electricians, mechanical engineers, manufacturers and dealers in electrical apparatus, and suppliers of electricity. Signatories (with 1 share each): G. S. Corlett, Wigan; T. D. G. Drayton, Newton-le-Willows, Lancashire; C. G. Jackson, Anderton Hall, Lancashire; W. Johnson, Harewood, Roe Lane, Southport; J. Brown, 28, Oxford Road, Birkdale, Lancashire; W. H. Hewlett, Wigan; T. R. Ellis, The Hollies, Wigan. The number of the directors is not to be less than three nor more than seven, the first to be appointed by the subscribers. Qualification, £300. Remuneration to be fixed by the company in general meeting. Registered on the 7th inst. by Mr. C. Doubble, 14, Sergeant's Inn, Temple, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Isle of Wight Electric Lighting Company, Limited.—The statutory return of this company, made up to the 7th inst., was filed on the following day. The nominal capital is £1,000, divided into 940 ordinary and 60 founders' shares of £1 each. 7 ordinary shares have been taken up, but no calls have been made. Registered office, 21, Lime Street, London.

Miners' Lamp Electric Lighting Company, Limited.—The annual return of this company, made up to February 1st last, and filed on the 29th ult., shows that out of a capital of £3,000 in £5 shares, 301 shares have been taken up, of which 190 have been issued as fully paid. Upon the remainder the full amount has been called, and all calls, with the exception of £5, have been paid. Registered office, 118, Albion Street, Leeds.

Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited.—The annual return of this company, made up to February 12th, 1891, was filed on the 16th ult. The nominal capital is £120,000 divided into 15,000 priority and 9,000 founders' shares of £5 each. All of these have been taken up, and 6,000 founders' have been issued as fully paid. Upon the remaining shares the full amounts have been called, and the calls paid amount to £90,020 (which includes £20 paid on 20 priority and 20 founders' shares forfeited). Registered office, 64, Cannon Street, E.C.

South Western District and Thames Valley Electricity Supply Company, Limited.—The annual return of this company made up to the 31st December last, was filed on the 14th ult. The nominal capital is £100,000 in £10 shares, of which seven have been taken up, but on which no calls have been made. A note in the "Remarks" column of the return states that "nothing has yet been done in this company beyond the registering the name and paying the registration fees, but it is intended to begin work next autumn. The stagnation has been due to the enforced absence of myself abroad since November 1890, until quite lately (signed) Daniel de Castro, Chairman." Registered office, Battersea Foundry, Battersea, S.W.

Thornebury Miner's Safety Lamp Company, Limited.—(Safety lamp manufacturers, mechanical and electrical engineers, &c.).—The annual return of this company made up to the 8th ult., was filed on the 14th ult. The nominal capital is £50,000 in £1 shares, of which 30,057 have been taken up and 20,540 issued as fully paid. The full amount has been called on the remaining 9,517, and the calls paid amount to £8,976, leaving £541 in arrears.

The return for 1891, made up to the 31st December, 1891, was filed on the 16th ult, when 30,057 shares were taken up, of which the same number were issued as fully paid. The calls then paid amounted to £7,704 5s., and £1,812 15s. was unpaid. Registered office, 85, Gracechurch Street, E.C.

Electric Construction Corporation, Limited.—The following was filed on the 1st April, 1892: At an extraordinary general meeting of this company, duly convened and held at Worcester House, Walbrook, E.C., on Thursday, March 3rd, 1892, the following resolution was duly passed, and at a subsequent extraordinary general meeting of the company, also duly convened and held at the same place, on Tuesday, March 22nd, 1892, the following resolution was duly confirmed as a special resolution: "That the capital of the company be increased to £750,000 by the creation of 25,000 new shares of £10 each, numbered 50,001 to 75,000 inclusive." (Signed) J. Spencer Balfour, chairman.

Bicester Electricity Supply Company, Limited.—The statutory return of the above-named company made up to the 16th ult., was filed on the 30th ult. The company has a nominal capital of £5,000 in £5 shares, of which 131 have been taken up, 10s. per share called, and all calls paid. Registered office, Market Hill, Bicester, Oxon.

Pontypridd Electric Lighting Company, Limited.—The annual return of this company, made up to the 16th March, 1891, was filed on the 4th ult. The nominal capital is £10,000 in £5 shares, and of these 7 shares have been taken up, no calls, however, having been made. Registered office, 40 Mill Street, Pontypridd, Glamorgan.

BUSINESS NOTICES, &c.

Fire at Messrs. Davis and Timmins, Limited.—We much regret to have to announce that at an early hour on Sunday morning the premises of Messrs. Davis and Timmins, Limited, of 24, Charles Street, Hatton Garden, were entirely destroyed by fire. The fire, it appears, broke out in the adjoining premises and took such rapid hold, that before the brigade could get the fire under control, the whole of the valuable plant of machinery and extensive stock belonging to Messrs. Davis and Timmins, Limited, was lost. Messrs. Davis and Timmins, we believe, were fully insured, but it must take time before they are able to replace their machinery. A circular which has been issued by the firm states that they have arranged for the present to carry on the whole of their business at their works at York Road, King's Cross, and they hope by this means to be able to prevent any inconvenience to their customers, pending the rebuilding of the Charles Street premises. Although most of the books have been saved, Messrs. Davis and Timmins would be obliged, in order to avoid delay, if their customers will furnish them with copies of any orders unexecuted, and fresh samples.

The Belfast and Dublin Telephone Service.—Last week there was a large meeting of merchants and others at the Belfast Chamber of Commerce at the opening of the telephone trunk wire between Belfast and Dublin. Speeches delivered in Dublin were heard quite distinctly at Belfast. The work has been carried out by the National Telephone Company from Belfast to the boundary of their district, and by the Telephone Company of Ireland from Dublin to the boundary also, to meet the National Company's lines, the boundary being about midway between the two cities. Under the arrangements made for working the trunk line it will be possible for people in the towns of Lisburn, Larne, Newtownards, or Bangor to communicate through the call offices with Dublin in the same way as will be the case in Belfast. As regards Newry, which is one of the towns taken in by the trunk line, it has been found possible to have about a couple of hours' connection in the day, but it is hoped that later on there will be provided complete connection in the same way as in the other towns. The connection between Dundalk, Drogheda and Belfast is said to be very satisfactory.

The Electric Light in the West End.—Since our last visit to this district we find that Mr. J. C. Howell is carrying out an installation at No. 102, Harley Street, W. Messrs. W. A. S. Benson & Co., of Old Bond Street, are carrying out an installation at No. 84, New Bond Street, where structural alterations are in course of completion. Messrs. Watson, Gersenheiner & Co., of Glasshouse Street, W., are fitting up an installation in the studios of Messrs. Lock and Whitfield, Photographers, 178, Regent Street, W. Messrs. Laing, Wharton and Down are putting in an installation in the premises of Messrs. Wilson & Co., goldsmiths and silversmiths, 132, Regent Street. The Hotel de Paris et de l'Europe, Leicester Square, is being fitted throughout with the electric light by Messrs. E. L. Berry, Harrison & Co., of Whitcomb Street, E.C.

Barnett, Wynne and Barnard.—We understand that Messrs. R. H. Barnett & Co., electric light and general engineers, Volt Works, Walker Gate, near Newcastle-upon-Tyne, have taken over the whole of the works, stock, plant, and machinery of the late

firm of Barnett, Wynne & Barnard, as a going concern, and they are prepared to undertake electrical work of all kinds, including telephones, electric bells and mining signals; electric light installations for ships, collieries, buildings, &c.; and the electrical transmission of power for all purposes. The business will be carried on under the direct supervision of Mr. R. H. Barnett, the late senior partner of the firm of Barnett, Wynne & Barnard, who took a large share of the management of the electrical department of the late firm.

Catalogues.—We have received from the General Electric Power and Traction Company a copy of their third edition Telephone Catalogue. Useful information and illustrations as well as full particulars regarding prices, are given of the company's telephones and accessories for internal and external construction. We understand that it is the company's intention to issue this week, a complete treatise on the fitting and construction of telephones, which should meet a long-felt want.

We have received from Messrs. John Musgrave and Sons, Limited, a handsomely illustrated catalogue of engines, boilers, &c.

Tenders Wanted.—Huddersfield.—The Corporation of Huddersfield invite tenders for the electric wiring and electric light fittings for the Town Hall and Borough Offices. Specification and plans may be obtained from Mr. A. B. Mountain, Borough Electrical Engineer, 1, Peel Street, to whom tenders must be addressed, endorsed "Tender for Electric Wiring of Town Hall," and delivered not later than 10 a.m. on Thursday, April 28th, 1892. No allowance for estimates. Applications to be made to H. Barber, Town Clerk, Town Hall, Huddersfield

Glasgow Electric Lighting.—We hear that the sub-committee on contracts have accepted the following tenders for work to be done at, and in connection with, the new central electric light station in Waterloo Street, Glasgow. For the boilers, the tender of Messrs. Lindsay, Burnet & Company. For the engines, dynamos, &c., including steam and exhaust pipes, the tender of Messrs. Latimer Clark, Muirhead & Company, London.

CITY NOTES.

Maxim-Weston Electric Company, Limited.

MR. JOHN MARKS, one of the liquidators of this company, presided on Friday last at a meeting of the shareholders, held at Cannon Street Hotel, to receive the accounts showing the manner in which the winding up of the company has been conducted and the property disposed of.

The CHAIRMAN explained the accounts in detail, and stated that Mr. Watt's claim, which was for upwards of £1,700 and damages, had been successfully resisted, and that £1,000 had been recovered against him by the liquidators, as well as costs in both actions. Mr. Watt had claimed to be a holder of 7,376 shares, but that claim had been reduced to 4,416, after long argument before the arbitrator. Upon the old company there was a balance of £414, and subject to what might be voted to the liquidators that would be carried forward to the accounts of the new company. He moved that the report and accounts be adopted.

Sir HENRY HOARE seconded the motion.

Mr. NEWTON said it was one of the most deplorable results of a public company of which he, in his long experience, was aware. He was surprised that there was not a single word of indignation from the shareholders as to the way in which the company had been managed, and the shareholders' interests neglected. There was scarcely anything left for the shareholders who had placed their money in the concern. Out of the remaining balance, however, he thought they ought not to forget the liquidators who, against great odds, and under very heavy pecuniary responsibilities, had taken the matter in hand.

The report and accounts having been adopted, a long discussion ensued as to the amount which should be voted to the liquidators, and ultimately it was agreed, on the motion of Mr. F. Beard, seconded by Mr. H. Jones, that 200 guineas should be voted, of which 100 should go to Mr. Marks, 60 to Mr. Swaby, and 40 to Mr. Klench.

A meeting of the new company was then held, and Mr. Marks explained the accounts of the liquidators, which showed that in addition to the balance brought forward from the old company, there was cash in hand amounting to £1,249, and in reply to questions he said that there were 268,755 shares, and that the balance in hand would be very little more than sufficient to pay 1d. upon each share.

The meeting, after adopting the report and accounts, voted 100 guineas to Mr. Marks, and 75 to Mr. Hodgson, the liquidators of the new company.

Electric Construction Corporation.

MR. J. S. BALFOUR, M.P., presided at an extraordinary general meeting of the shareholders of the Electric Construction Corporation, on Thursday, 7th inst., when the following resolutions, passed on the 22nd ult., were confirmed, namely, "That one-half of the new shares be allotted and issued by the directors to such persons and at such times as the directors shall think proper, and that the said shares shall be preference shares, and shall entitle the holders thereof to a cumulative dividend at the rate of 7 per cent. per annum upon the amount credited as paid up thereon, in priority to any dividend on the ordinary and founders' shares of the company." "That the said preference shares shall also entitle the holders thereof, upon a return of capital of the company, to be repaid the amounts credited as paid thereon before any payment in respect of capital is made on the ordinary and founders' shares of the company."

The Oriental Telephone Company, Limited.

THE directors' report for the year ending December 31st, 1891, states that the revenue account for the year shows a balance to credit of £8,918 13s. 10d., which has been transferred to profit and loss, and including £2,250 19s. 9d. brought forward from the previous year, a balance remains for disposal of £11,169 13s. 7d. The directors propose to deal with this as follows:—To write off £257 0s. 4d. legal and other expenses caused by the action brought by holders of vendors' shares; £1,466 4s. 8d. in reduction of capital expenditure; to add £3,000 to reserve fund, which will then stand at £10,000, and to pay a dividend of 2½ per cent., free of income tax, on the total paid-up capital of the company, carrying forward £1,957 16s. 4d. As the shareholders are aware, a large portion of the earnings of the company are in silver currency, and, owing to the low exchanges which have lately been ruling, the profit of the year has been somewhat diminished. As mentioned in the report of last annual general meeting, a copy of which was sent to each shareholder, proceedings were taken by a holder of vendors' shares to restrain the directors from distributing the profits of the company in the manner indicated in the last annual report and accounts. The Court having upheld the action of the directors, the distribution for the past year will be made in the same manner, the 2½ per cent. on the entire paid-up capital of the company being equivalent to £3 12s. 2d. per cent. on each ordinary share of 11s. paid, issued prior to February 4th, 1886. The Indian companies continue to improve. The Bengal Company has been able to increase its dividend by ½ per cent., the distribution for 1891 being 5½ per cent., whilst the Bombay Company has declared a dividend equal to that of the preceding year, viz., 4 per cent., transferring Rs. 10,000 to its reserve and depreciation fund. The Bengal Company already possesses a reserve fund in cash of Rs. 50,000. The Telephone Company of Egypt, after payment of debenture interest, has declared its usual dividend of 6 per cent. on the preferred shares, carrying forward £1,414 17s. The China and Japan Telephone Company's accounts for 1890 closed with a surplus of £841 12s. 5d., as against £573 16s. 4d. for the previous year. The accounts for the past year are now in course of preparation. The branches worked directly by the company maintain their revenues, and in one or two instances show slightly improved results. The shareholders will remember that last year they approved a resolution to alter the company's memorandum of association so as to embrace "any business or manufacture relating to the generation, employment, or utilisation of electricity or magnetism, or the apparatus connected therewith." This resolution having been duly confirmed, application was made to the Court for permission to amend the company's memorandum accordingly. The application was, after consideration, sanctioned, but the Court suggested that as the power of extension of business was considerable, the name of the company should be altered, and expressed approval of its being changed to the "Oriental Telephone and Electric Company, Limited." The directors see no objection to such alteration, and the resolution mentioned in the notice on the back hereof will therefore be submitted for the consideration of the meeting. The directors to retire at the present meeting are Messrs. Henry Grëwing and William Addison, both of whom being eligible, offer themselves for re-election. The auditors of the company, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election.

The Indo-European Telegraph Company, Limited.—The directors of the Indo-European Telegraph Company at a meeting on Monday last, after adding £10,000 to the reserve fund, determined, subject to audit, to recommend the payment of a dividend for the six months ended December 31st, 1891, of 17s. 6d. per share, making with the interim dividend already paid 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year. The dividend and bonus will be payable on and after May 1st next.

The report of the Indo-European Telegraph Company, Limited, for 1891 shows that the revenue from all sources amounted to £116,699, as compared with £113,807. Deducting the expenses, taking credit for £4,168 brought over from 1890, and debiting income tax, there remains £58,483, from which £10,000 has been placed to reserve, and that sum, together with £10,625, the amount of interim dividend, have to be deducted, leaving £37,858. The directors propose a dividend for the six months ending December 31st, of 17s. 6d. per share, making 6 per cent. for the year, and a bonus of 20s. per share, both tax free, making in all 10 per cent., carrying forward £5,983.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 3s. 6d. per share, free of income tax, being at the rate of 3½ per cent. per annum for the quarter ending March 31st, 1892, such dividend to be payable on and after the 23rd inst.

Submarine Cables Trust.—It is announced that a payment of £1 2s. 6d. will be made on account of the coupon, due on April 15th, on the 16th instant, by Messrs. Glyn, Mills, Currie & Co.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 8th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, amounted to £3,052.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation, April 7th.	Closing Quotation, April 13th.	Business done during week ending April 13th, 1892. Highest.	Lowest.
250,000£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 — 103	102½	101½
1,300,980£	Anglo-American Telegraph, Limited	Stock	49¼— 50¼	48½— 49½xd	49½	49
2,849,510£	Do. do. 6 p. c. Preferred	Stock	88½— 89½	87½— 88½xd	89½	88
2,849,510£	Do. do. Deferred	Stock	11¼— 11⅝	11¼— 11⅝	11⅝	11⅜
130,000	Brazilian Submarine Telegraph, Limited	10	10¾— 11¼xd	10¾— 11¼	11¼	11
53,200£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3½	3 — 3½	3½	3 1/16
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2¼	2 1/16
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½— 4½	3½— 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	7½— 8	7½— 8	7½	...
$7,716,000	Commercial Cable, Capital Stock	$100	155 —160	155 —160	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅜— ½	⅜— ½	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5⅛— 5⅜	5⅛— 5⅜	5¼	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 3⅝xd	3½— 3⅝	...	...
6,000	Do. do. 10 p. c. Preference	5	8½— 9½xd	8½— 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11½— 11⅝	11⅛— 11⅜xd	11½	11¼
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 15	14⅜— 14⅝xd	15	14 13/16
70,000	Do. 6 p. c. Preference	10	15½— 15⅝	15 — 15⅛xd	15⅝	15 5/16
200,000£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	...	...
1,200,000£	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 —112	109 — 112	111	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞— 15⅛	15 — 15⅛	15 3/16	14 15/16
78,300£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	...	...
276,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	107 —110	108 —111	...	...
135,000£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	102 —105	102¼	...
180,400£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	101⅛	101½
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5⅜— 6¼	5⅜— 6¼	6 1/16	5⅝
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅜— 1⅝	1⅜— 1⅝	1 1/16	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜— 2⅞	2⅜— 2⅞	2⅝	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1½— 1⅝	1½— 1⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10 — 10¼	10 — 10¼	10 5/16	10
180,042	Do. do. 6 p. c. Preference	10	15 — 15½	15 — 15½xd	15 5/16	15¼
150,000	Great Northern Tel. Company of Copenhagen	10	18⅜— 19½	18⅜— 19½	...	...
220,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 466/ to 14,000 ...	10	7¾— 8½	7¾— 8½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20 — 21	19½— 20½	...	...
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —105	102 —105	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42⅜	42¼
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	4 — 5	4½— 5½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	2⅞— 3	2⅞— 3	2⅞	2⅝
10,000	Do. do. fully paid	5	5 — 5⅛	5 — 5⅛	5 1/16	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8¼— 8⅝	8¼— 8⅝	8⅝	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4¼— 4½	4 9/16	4 5/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13½	12½— 13½	13⅜	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	11½— 12½	12 — 12½	12 5/16	12⅛
420,000£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	106 —108	107 —109	107½	106½
250,000£	Do. (issued at 5 p.m., all paid)	...	79 — 81	79 — 81	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4 — 4½	4½— 5½	4⅜	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	7 — 8	6 — 7	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¼— 8⅜	8¼— 8⅜	8⅝	8 7/16
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7½— 8	7½— 8	7 13/16	7¾
3,381	Submarine Cables Trust	Cert.	116 —121	116 —121	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3⅜— 4¼	3⅜— 4¼	4 1/16	4
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	42¼
150,000£	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400£	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	101	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3½— 4½	...	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 — 106	102 —106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	10 — 10½	10 — 10½	10 5/16	10
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6⅝	...
30,364	Do. do. do. 5 p. c. Deferred	7½	4 — 4½	4 — 4½	4¼	...
189,700£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	104 —107	...	...
237,200£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 1⅞	1⅝— 1⅞	1⅝	1 11/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10½	10¼
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½— 9½	9 — 10	9	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	99 —103	99 — 103	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100£	Do. do. 6 p. c. Sterling Bonds	10J	97 —100	97 —100	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼— 6⅝	6½— 7	6⅝	6 9/16

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7½—7⅞.—Electric and General Investment, shares of £5 (£1 paid), 2—2½.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders' shares, 6⅞—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—7 per cent. Preference Shares of £5 (fully paid) 5½—5⅝.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅝—6, 1st Preference Cumulative 6 per cent., £5 (fullypaid), 5¾—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5—5⅛.—Do. shares of £5 (£3 paid), 2⅜—2⅝.—London Electric Supply Corporation, Ordinary (£5 paid), ⅞—1⅛.—Do. 6 per cent. Preference, 1⅛—1⅜.—Manchester, Edison and Swan Company, £9 (£1 paid) ⅛—¼.—Metropolitan Electric Supply Company, Founders' Shares, 300—400.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ¼—½.—£5 Preference (fully paid), 2½—2⅝.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

Bank Rate of Discount.—2½ per cent. (April 7th, 1892).

AN EXPERIMENTAL STUDY OF THE WASTE FIELD OF DYNAMOS.*†

BY WM. L. PUFFER, Instructor in Physics.

IN 1886 a remarkable paper was published by Drs. John and Edward Hopkinson concerning the magnetic circuit of certain types of dynamos. In this paper were given some measurements of the quantity called "ν," or the ratio of the total flux of force in the field magnet to that in the armature; this was found to be about 1·32.

The method used was the ballistic galvanometer one of measuring induction through a closed magnetic circuit, the dynamo magnet being so regarded. Turns of wire were placed around the field coils, armature, and other parts of the machine, as well as in the air about the magnet. The published report states that the magnets were alternately excited and short circuited; the terminals of the secondary coils were connected in turn to a reflecting galvanometer with a weighted needle.

In a paper read before the Institution of Electrical Engineers in February, 1890, Mr. W. B. Esson gave a table of values of "ν" for different dynamos. This table will be quoted later in the paper. At my suggestion, Messrs. Brown and Greenlaw decided to make an extended and careful set of tests on a number of forms of dynamo magnets which were in the dynamo room of the Physical Department. After a few experimental trials, the apparatus and circuits were arranged in the following manner:—All observations were taken in a basement room remote from the electrical and mechanical disturbances of the dynamos. A Hartmann galvanometer was set up, with a wooden block substituted for the copper one in which the bell magnet is usually placed. The coils used with the instrument were of about 356 ohms, connected in series; an adjustable resistance was used to control the extent of the deflection without change of adjustment of galvanometer coils. This resistance was kept constant during a test. The deflections were read by a telescope and scale. A few turns of wire were wound over the regular coils and put in circuit with a suitable resistance, a cell of battery and reversing key, to enable the observer to quickly bring the needle to rest after a deflection had been received.

Exploring coils were wound upon different parts of the dynamo to be tested, the number of turns of each coil was chosen so that the deflections of the ballistic galvanometer should in all cases be as nearly alike as convenient. A mercury cup switchboard was arranged with a set of cups for the terminals of each coil, and an ebonite block with two pins in it was arranged with flexible twisted wires, so that the galvanometer could be quickly connected to any one of the exploring coils.

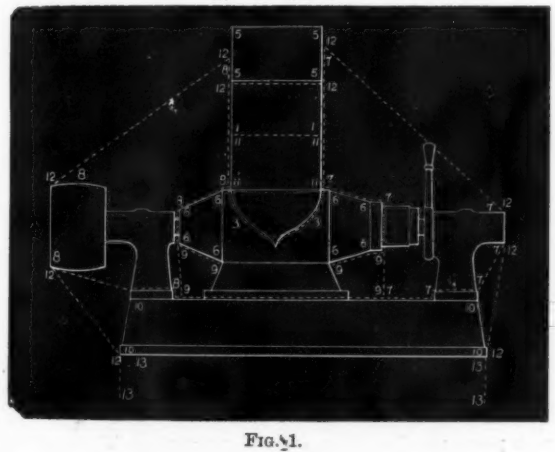


FIG. 1.

The dynamo experimented upon was necessarily at rest, and the fields excited by another machine; the current in the magnet coils was of the strength it should be if the machine were running properly at no load. Of course the values of "ν" thus obtained are not correct for the machine when running either at partial or full load.

The method of conducting the experiments was for the observer at the galvanometer to signal by telegraph to the operator at the dynamo his readiness to receive a deflection, at which the field circuit was closed; on again receiving a signal the circuit was opened. The same readings were then taken with the galvanometer commutator reversed, and in turn the procedure was repeated for all the coils upon the machine. Several series of deflections were taken at each time of experimenting, and from these means the results were calculated.

The Edison dynamo was first chosen on account of the simplicity of its construction. It is rated as a No. 4 dynamo, having a capacity of 150 110-volt, 16 candle-power, incandescent lamps, and as the lamps furnished with the dynamo average about 50 watts each, this is equivalent to rating the machine at 7,500 watts; but as the ammeter is marked full load at 80 ampères corresponding to 8,800 watts, the exact rating is doubtful. The dynamo will give an output of 90 ampères all day and run cool and give no trouble.

DIMENSIONS.

Taken from a blue print.

Wrought iron magnet cores ..	7¾ inches in diameter, 12¼ inches long.
Wrought iron yoke	10½ inches long, 5½ inches wide and thick.
Cast iron pole pieces	12 inches long, 7⅛ inches high.
Clearance	⅛ inch.
Horns of pole pieces	2¾ inches apart.
Armature core washers	6½ inches in diameter, with 2¾ inch hole.
Armature core	12 inches long, 6¼ inches in diameter.
Revolutions per minute	1,520

Fig. 1 will show better than words the position of the various exploring coils which will be named as follows:—

EXPLORING COILS.

Coil.	Turns.	Position.
1	1	Middle of magnet spool.
2	1	Middle of magnet spool.
3	1	Pole piece.
4	1	Pole piece.
5	1	Middle of yoke.
6	1	Armature, including heads.
7	6	Space, including commutator and bearing.
8	6	Space, including pulley and bearing.
9	10	Space between armature and iron base.
10	5	Iron bed-plate.
11	12	Between magnet coils from armature to plane of 1 and 2.
12	1	Whole machine and bed-plate, except yoke.
13	5	Under bed-plate to a depth of about 14 inches.

Two methods were used to produce the magnetisation and demagnetisation of the machine, which I will call the first method and the second method, respectively. In the first method the field magnet circuit was completed and broken by means of the main switch of the dynamo. A considerable arc was formed upon breaking, which was at first reduced by connecting the pilot lamp across the magnet terminals; but as this reduced the deflection, its use was given up and the arc allowed to burn. This method is objectionable on account of the great strain the insulation of the wire has to stand, and would not be safe to use on high voltage machines. The second method was devised to put less strain on the insulation, as well as to find what the difference would be between it and the first method. The magnet was connected in series with a suitable resistance to mains of higher voltage (180 volts), and a snap-switch arranged to demagnetise the machine by short-circuiting it, and to magnetise it when the short circuit was opened. This method worked very well and was perfectly satisfactory in every way. It was found that when the machine was magnetised, these methods gave practically the same results, both in the value of the deflections and in the percentage distribution of the lines of force; but when the machine was demagnetised, the deflections of the first method were slightly more than twice as great as in the second, although the percentage values were not so widely different.

The table shows the mean percentage distribution of the magnetisation as found by both the first and second methods, and also the mean of these; one hundred per cent. represents the mean value of the magnetisation of the field coils.

EDISON INCANDESCENT DYNAMO.

Percentage Distribution of Magnetisation.

Coil.	Position of Coil.	First Method.		Second Method.		Average.	
		Mag.	Demag.	Mag.	Demag.	Mag.	Demag.
1 & 2	Middle of magnetising coils... ...	100·	100·	100·	100·	100·	100·
3 & 4	Pole pieces	86·8	84·0	86·0	83·1	86·4	83·6
5	Middle of yoke ...	98·3	96·3	96·5	97·3	97·4	96·8
6	Armature, including heads	65·8	63·5	64·8	63·7	65·3	63·6
7	Space, including commutator and bearing	2·3	2·3	2·6	2·6	2·5	2·5
8	Space including pulley and bearing	2·9	3·0	2·9	3·3	2·9	3·2
9	Space between armature and bed-plate	3·8	3·6	3·8	3·7	3·8	3·7
10	Iron bed-plate ...	9·3	8·8	9·2	8·3	9·3	8·6
11	Between magnet coils	5·6	6·0	5·6	6·4	5·6	6·2
12	Whole machine and bed, except yoke	...	...	90·1	90·5	...	...
13	Wood frame under bed-plate	...	...	2·6	2·9	...	...
	The value of "ν" is	1·52	1·57	1·54	1·57	1·53	1·57

* I have embodied in this paper the results of the graduating thesis of Messrs. Edward D. Brown and Frank M. Greenlaw, of the class of 1890, Massachusetts Institute of Technology, together with some of my own measurements made in the winter of 1887-88.

† *Technology Quarterly.*

I am not able to satisfactorily explain the cause of variation between the two methods or between the makes and breaks, but I am inclined to think it is due mostly to the fact that the ballistic method assumes one condition which cannot hold with large magnetic circuits, and that is, that the needle receives the impulse before it has moved appreciably. Probably these discrepancies would not be observed if a galvanometer should be made with a specially constructed needle of great mass, built up of thin laminæ so arranged that the poles of the magnetic system would not be altered by the current in the coils of the instrument.

The leakage along the magnet limbs is shown by fig. 2, which gives

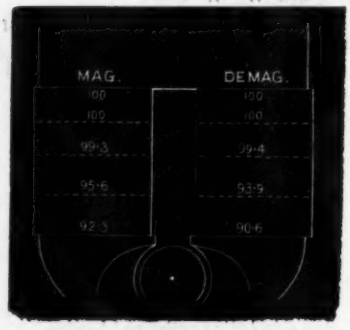


Fig. 2.

the positions in which the exploring coil was placed and the values obtained.

Thomson-Houston Incandescent Dynamo.

This dynamo is of very peculiar design, being in the main an adaptation of the well-known Thomson-Houston arc light pattern to an incandescent machine. The spherical armature revolves between the cup-shaped ends of two horizontal cylindrical cores, each of which has a heavy flange on its outer end. These flanges are connected by sixteen two-inch wrought iron bars, as well as by two heavy cast iron side brackets which support the main bearings of the armature shaft, and have downward projections to serve as the four legs upon which the machine stands.

As there is very little external evidence of magnetism when the dynamo is running, and the yoke bars and brackets are in effect a closed cylindrical iron shell, with its axis concentric with the axis of the magnet cores, preliminary examination was made with a small compass, and the general direction of the leakage determined. These leakage lines were substantially like those given in Hering's "Principles of Dynamo-Electric Machinery."

Strong consequent points were found in the yoke bars, and a number of trials had to be made before a satisfactory set of exploring coils could be arranged. This dynamo was presented to the Physical Department with the understanding that its rating was 9,600 watts at a speed of 1,250 revolutions per minute, and a voltage of 110; but the same size machine was listed as a 200-light dynamo with an output of 12,600 watts. It will easily run all day delivering 150 ampères at 110 volts, or 16,500 watts, without any undue heating or trouble of any kind. Exploring coils were arranged as shown in fig. 3.

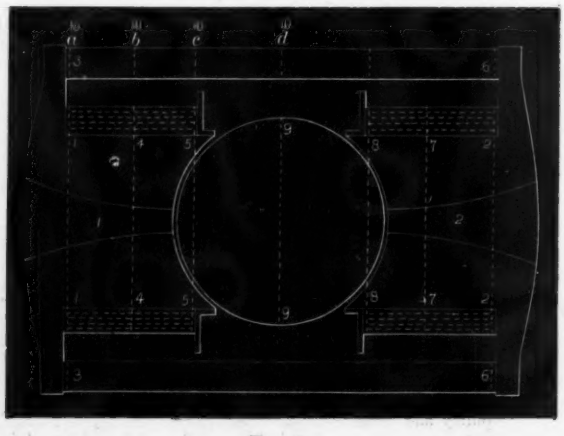


Fig. 3.

A small compass was used in determining the proper positions for these coils; very little magnetism was evident outside of the machine, but there was a very strong field between the poles and the yoke bars. The method of making and breaking the field circuit was alone employed on this dynamo, as well as on all other machines tested.

The table shows the percentage distribution of the magnetisation as found both by magnetising and demagnetising. Coil 2 is lower than 1, and 8 than 5, probably because of the German silver turns which were short-circuited for regulation of potential of the dynamo; in this machine the resistance is wound on the machine itself and cut out when necessary by suitable screws and slides on the top of the magnet spools.

Exploring Coils.

Coil.	Turns.	Position.
1	1	Maximum position on magnet spool No. 1, about ½ inch from flange.
2	1	Maximum position on magnet spool No. 2, about ½ inch from flange.
3	1	Yoke bars and brackets No. 1.
4	1	Middle of magnet spool No. 1.
5	1	Armature end of magnet spool No. 1.
6	1	Yoke bars and brackets No. 2.
7	1	Middle of magnet spool No. 2.
8	1	Armature end of magnet spool No. 2.
9	1	Armature.
10	5	Movable coils around one group of 4 yoke bars.
11	5	End of yoke bracket. Commutator side. Plane of 10 a.
12	6	Yoke bracket opposite magnetic pole. Commutator side. Plane of 10 c.
13	6	End of yoke bracket. Pulley side. Plane of 10 a.
14	6	Yoke bracket opposite magnet pole. Pulley side. Plane of 10 c.
15	6	Middle of yoke bracket. Pulley side. Plane of 10 d.

Although these results are of value in the study of dynamo magnets, it must be remembered that this machine was at rest, and there was no current in the armature or series winding. The series turns are placed over the armature and at such a fixed inclination as to tend to neutralise the cross magnetisation of the armature, rendering the frequent adjustment of the brushes unnecessary. These series coils are very powerful and must make a very decided difference in the distribution of magnetism.

Thomson-Houston Incandescent Dynamo.

Percentage Distribution of Magnetisation.

Coil.	Position of coil.	Mag.	Demag.
1	Maximum position, spool No. 1	100·0	100·0
2	Maximum position, spool No. 2	98·7	99·1
3	Yoke bars and brackets No. 1	94·3	93·5
4	Middle of spool No. 1	95·5	96·6
5	Armature end of spool No. 1	81·5	82·5
6	Yoke bars and brackets No. 2	93·5	92·2
7	Middle of spool No. 2	95·3	96·2
8	Armature end of spool No. 2	80 3	79·9
9	Armature	70·6	71·1
10a	Yoke bars	18·8	18·2
10b	Yoke bars	18·1	17·1
10c	Yoke bars	15·6	15·2
10d	Yoke bars	14·2	13·6
11	End of yoke bracket, commutator side ...	8 7	8·6
12	Yoke bracket opposite pole, commutator side	5·7	5·4
13	End of yoke bracket, pulley side	12·1	11·4
14	Yoke bracket opposite pole, pulley side ...	9·1	8·1
15	Middle of yoke bracket, pulley side ...	7·7	6·9
	The value of "v" is...	1·42	1·40

The Weston Incandescent Dynamo.

This dynamo is of the well-known double magnetic circuit form, made to run 60 70-volt 16-candle-power lamps. The magnet spools, four in number, are placed horizontally and wound on wrought-iron elliptical cores 8 inches long with axes about 5 and 11 inches. The yoke pieces are of cast iron, practically rectangular in cross section,

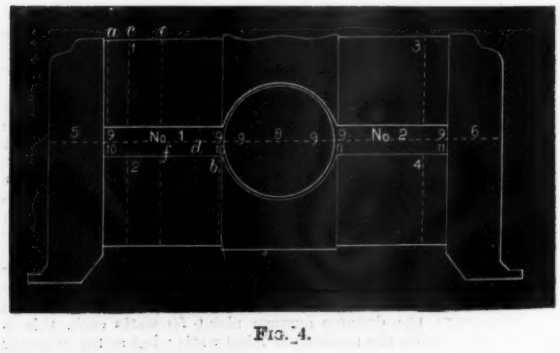


Fig. 4.

with an area of about 38 square inches. The two pole-pieces are also of cast iron, with a section of about 90 square inches. The total length of a single magnetic circuit is about 45 inches. Figure 4 shows the positions of the exploring coils used. The composition bearing at the pulley end of the shaft is held by arms which project

from the upper and lower pole piece, and come so near together that it would seem as if together with the shaft a very good path was available for stray lines of force. Coil 7 was wound upon one of the iron supports, and is not shown on the figure.

EXPLORING COILS.

Coil.	Turns.	Position.
1	1	Upper magnet spool No. 1, two inches from yoke
2	1	Lower magnet spool No. 1, two inches from yoke
3	1	Upper magnet spool No. 2, two inches from yoke
4	1	Lower magnet spool No. 2, two inches from yoke
5	1	Yoke No. 1
6	1	Yoke No. 2
7	10	Pulley bearing arm
8	1	Armature
9	1	Whole plane
10	10	Between spools magnet No. 1
11	10	Between spools magnet No. 2

One half of the sum of the deflection from coils 1, 2, 3, 4, is taken as 100 per cent. in the table of percentage distribution. The four values were almost identical, indicating a very good balance of the windings.

WESTON INCANDESCENT DYNAMO.

Percentage Distribution of Magnetisation.

Coil.	Position of Coil.	Mag.	Demag.
1 & 2	Upper and lower magnet spool No. 1 ...	100·0	100·0
3 & 4	Upper and lower magnet spool No. 2 ...	100·0	100·0
5	Yoke No. 1	93·3	93·0
6	Yoke No. 2	93·3	93·0
7	Pulley bearing arm	3·7	3·7
8	Armature	78·9	78·8
9	Whole plane	91·8	93·0
10	Between spools No. 1	3·3	3·3
11	Between spools No. 2	3·4	3·4
1a	... ...	98·5	98·5
1c	... ...	100·0	100·0
1e	... ...	98·5	98·5
2f	... ...	99·0	98·5
2d	... ...	95·8	95·9
2b	... ...	91·5	92·4
	The value of "v"	1·27	1·27

THOMSON-HOUSTON MOTOR.

This motor has magnets of the inverted type of single magnetic circuit; the yoke is cast in one piece with the bed-plate. The armature bearings are supported by iron pillars from the bed-plate. The vertical magnet cores are of circular section about 7½ inches in diameter and 8¾ inches long. The pole pieces are 10 inches long and 8½ inches high. As this machine was in almost constant use, only a few measurements could be taken, and are given only as interesting

FIG. 5.

in connection with this paper, and not as the result of a careful and complete study of the waste field.

Coil 5 was arranged to see if there was a great leakage between the horns of the pole pieces, which appear to be very close together.

THOMSON-HOUSTON 220 VOLT, 10 H.P. MOTOR.

Percentage Distribution of Magnetisation.

Coil.	Position of Coil.	Mag.	Demag.
1	Magnet spool 2 inches from yoke. Maxm.	100·0	100·0
2	Magnet spool at yoke	99·0	99·6
3	Magnet spool at pole piece	91·4	92·2
4	Armature	75·9	75·1
5	Around armature, 1 inch from it... ...	78·1	78·6
	The value of "v" is	1·32	1·33

THE EDDY DYNAMO.

This machine was a special one made for the Mining Department of the Massachusetts Institute of Technology for a maximum output of 50 ampères at 50 volts. The old style Eddy motor frame was used in this machine, and at the request of the Eddy Company tests were made of magnetic leakages, efficiencies, &c., both with and without certain iron and composition parts. The object was to learn what could be done to improve the design of the machine, and incidentally to find out just what difference would be made by the substitution of some non-magnetic metal for iron in the construction of the bearing supports and pulley.

The method of studying the magnetic losses was substantially the same as already described, except that the results were calculated from the mean of the deflections produced by magnetising and demagnetising.

EXPLORING COILS

Coil.	Position.
1	Top of magnet.
2	Side of magnet.
3	Side of magnet close to pole pice.'
4	Side of magnet close to pole piece.
5	Space between armature and floor.
6	Space, including commutator and bearing.
7	Between magnet coils.
8	Space, including pulley and bearing.
9	Armature.

The "parts" mentioned consisted of the pulley and four large pins which screwed into the pole pieces and furnished supports for the composition bearing pieces. With the iron parts in place, there was a partial magnetic circuit through the two pulley bearing pins and the pulley, and also through the two commutator bearing pins, and the iron rocker-arm that carried the brushes.

EDDY DYNAMO.

Percentage Distribution of Magnetisation.

Coil.	Position.	Composition.	Iron.
1	Top of magnet	100·0	100·0
2	Side of magnet	95·0	95·6
3	Pole piece	88·1	88·9
4	Pole piece	88·5	89·4
5	Base	8·46	7·24
6	Commutator side	2·23	5·43
7	Between magnet coils	6·23	5·68
8	Pulley side	2·60	3·98
9	Armatures	66·9	61·4
	The value of "v" is	1·49	1·63

It is quite evident that with the iron parts in place there is less leakage of lines of force from the sides of the magnet, in the space over the armature and under the machine; but that the loss at the commutator side is increased about 100 per cent. and at the pulley side about 65 per cent., causing a loss of 8·8 per cent. in the armature. The change from iron to composition parts increased the commercial efficiency of the machine by about 1·6 per cent., not however, so much by a saving in the energy spent in the magnet as by reducing the eddy currents in the iron pulley, which became very perceptibly hot while running. Since these tests were made, this machine has been very greatly improved.

The following table gives the values of "ν" as found by W. B Esson, together with the values given in this article;

Machine.	Field.	Armature.	Remarks.	"ν"
Edison-Hopkinson	Single magnet	Drum	Poles next bed-plate	1·32
Siemens ...	Single magnet	Drum	Yoke next bed-plate	1·30
Phœnix ...	Single magnet	Cylinder	Yoke next bed-plate	1·32
Phœnix ...	Double magnet	Cylinder	Horizontal ...	1·40
Manchester	Double magnet	Cylinder	Bed and one pole common	1·49
Victoria ...	Double magnet	Ring	Ordinary pattern	1·40
Ferranti ...	Double magnet	Coreless	Alternating ...	2·00
Edison ...	Single magnet	Drum	... ...	1·53-1·57
Thomson-Houston	Single magnet	Sphere	... ...	1·42-1·40
Weston ...	Double magnet	Drum	... ...	1·27-1·27
Thomson-Houston motor type	Single magnet	Drum	... ...	1·32-1·33
Eddy ...	Single magnet	Drum	Composition parts	1·49
Eddy ...	Single magnet	Drum	Iron parts ...	1·63

Rogers Laboratory of Physics,
August, 1891.

PROCEEDINGS OF SOCIETIES.

The Royal Society.

Dynamo-Electric Machinery. By J. Hopkinson, F.R.S., and E. Wilson. Received February 15th, 1892.*

The following is intended as completion of a paper by Drs. J. and E. Hopkinson (*Phil. Trans.*, 1886, p. 331). The motive is to verify by experiment theoretical results concerning the effect of the currents in the armature of dynamo machines on the amount and distribution of the magnetic field which were given in that paper, but which were left without verification. For the sake of completeness, part of the work is given over again.

The two dynamos experimented upon were constructed by Messrs. Siemens Brothers & Co., and are identical, as far as it is possible to make them. They are mounted upon a common base plate, their axles being coupled together, and are referred to in this paper respectively as No. 1 and No. 2.

Each dynamo has a single magnetic circuit consisting of two vertical limbs extended at their lower extremites to form the pole-pieces, and having their upper extremities connected by a yoke of rectangular section. Each limb, together with its pole-piece, is formed of a single forging of wrought iron. These forgings, as also that of the yoke, are built up of hammered scrap iron, and afterwards carefully annealed. Gun-metal castings bolted to the base-plate of the machine support the magnets.

The magnetising coils on each limb consist of sixteen layers of copper wire 2 mm. diameter, making a total of 3,968 convolutions of each machine. The pole-pieces are bored out to receive the armature, leaving a gap above and below subtending an angle of 68° at the centre of the shaft. The opposing surfaces of the gap are 1·4 cm. deep.

The following table gives the leading dimensions of the machine:—

	cm.
Length of magnet limb	66·04
Width of magnet limb	11·43
Breadth of magnet limb	38·10
Length of yoke	38·10
Width of yoke	12·06
Depth of yoke	11·43
Distance between centres of limbs	23·50
Bore of fields	21·21
Depth of pole-piece	20·32
Thickness of gun-metal base...	10·80
Width of gap	12·06

The armature core is built up of soft-iron discs, No. 24 B.W.G., which are held between two end plates screwed on the shaft.

The following table gives the leading dimensions of the armature:

	c.m.
Diameter of core	18·41
Diameter of shaft	4·76
Length of core...	38·10

The core is wound longitudinally according to the Hefner von Alteneck principle, with 208 bars made of copper strip each 9 mm. deep by 1·8 mm. thick. The commutator is formed of fifty-two hard-drawn copper segments insulated with mica, and the connections to the armature so made, that the plane of commutation in the commutator is vertical when no current is passing through the armature.

Each dynamo is intended for a normal output of 80 ampères 140 volts, at 880 revolutions per minute. The resistance of the armature measured between opposite bars of the commutator is 0·042 ohm, and of each magnet coil 13·3 ohms.

In the machine, the armature core has a greater cross-section than the magnet cores, and consequently the magnetising force used therein may be neglected. The yoke has the same section as the magnet cores, and is therefore included therein, as is also the pole-piece. The formula connecting the line integral of the magnetising force and the induction takes the short form.

$$4\pi n c = 2 l_2 \frac{\mathrm{I}}{A_2} + l_3 f\left(\frac{\nu \mathrm{I}}{A_3}\right), *$$

where

n is the number of turns round magnet.
c is the current round magnet in absolute measure.
l_2 the distance from iron of armature to rim of magnet.
A_2 the corrected area of field.
I the total induction through armature.
l_3 the mean length of lines of magnetic force in magnets.
A_3 the area of section of magnets.

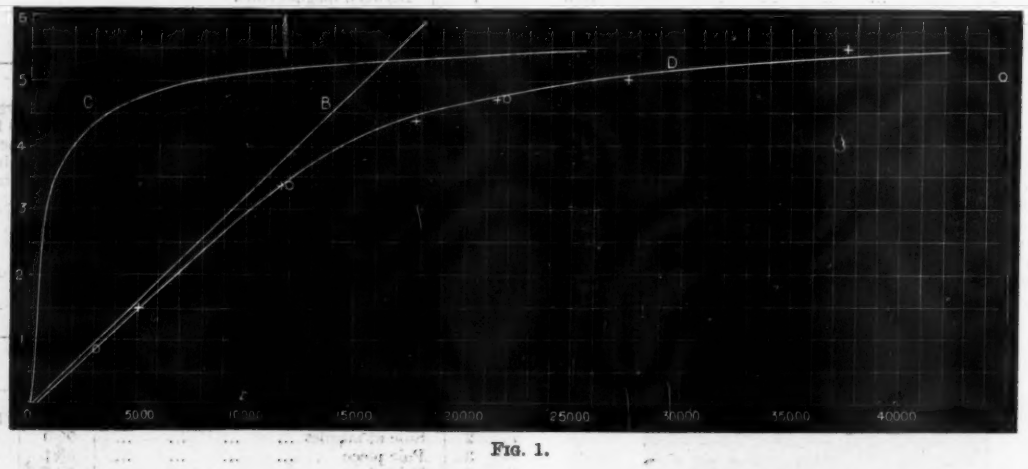


Fig. 1.

ν the ratio of induction in magnets to induction in armature.
f the function which the magnetising force is of the induction in the case of the machine actually taken from Dr. J. Hopkinson on the "Magnetisation of Iron," *Phil. Trans.*, 1885, figs. 4 and 5, Plate 47.

In estimating A_2 we take the mean of the diameter of the core and of the bore of the magnets 19·8 cm., and the angle subtended by the pole face 112°, and we add a fringe all round the area of the pole face equal in width to the distance of the core from the pole face. This is a wider fringe than was used in the earlier experiments (*Phil. Trans.*, p. 337), because the form of the magnets differs slightly. The area, so estimated, is 906 sq. cm.

l_2 is taken to be 108·8 cm.

A_3 is 435·5 sq. cm.

ν was determined by the ballistic galvanometer to be 1·47. It is to be expected that, as the core is actually greater in area than the magnets, ν will be more nearly constant than in the earlier experi-

* It must not be supposed from his name not appearing in this short paper that my brother, Dr. E. Hopkinson, had a minor part in the earlier paper. He not only did the most laborious part of the experimental work, but contributed his proper share to whatever there may be of merit in the theoretical part of the paper.—J. H.

* *Phil. Trans.*, p. 335.

ments. It was found to be constant within the limits of errors of observation.

Referring to diagram No. 1, the curve, C, is the curve $x = l_3 f\left(\frac{\nu}{A_3}\frac{y}{}\right)$, and the straight line, B, is the curve $x = 2\, l_2 \frac{y}{A_2}$, whilst the full line, D, is the characteristic curve of the machine

$$x = 2\, l_2 \frac{y}{A_2} + l_3 f\left(\frac{\nu}{A_3}\frac{y}{}\right),$$

as given by calculation.

The marks + indicate the results of actual observations on machine No. 1, and the marks 0 the results on machine No. 2, the total induction, I, being given by the equation:—

$$I = \frac{\text{Potential difference in volts} \times 10^8}{208 \times \text{revolutions per second}}.$$

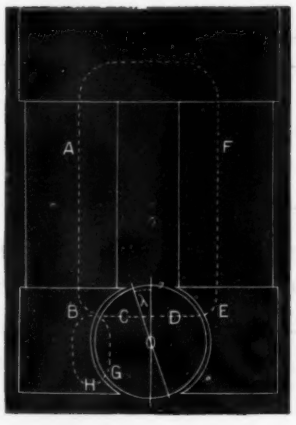
Experiments made upon the power taken to drive the machine under different conditions show that it takes about 250 watts more power to turn the armature at 660 revolutions when the magnets are normally excited than when they are not excited at all. The volume of the core is 9,465 cub. cm., or in each complete cycle the loss per cub. centimetre is $\frac{250 \times 10^7}{11 \times 9{,}465}$ = 24,000 ergs.

The loss by hysteresis is about 13,000 (*Phil. Trans.*, 1885, p. 463) if the reversals are made by variation of intensity of the magnetising force, and the iron is good wrought iron. This result is similar to that in the earlier paper (p. 352), where it is shown that the actual loss in the core, when magnetised, is greater than can be accounted for by the known value of hysteresis.

Effects of the Current in the Armature.

Quoting from the Royal Society paper, p. 342, "The currents in the fixed coils around the magnets are not the only magnetising forces applied in a dynamo machine; the currents in the moving coils of the armature have also their effect on the resultant field. There are in general two independent variables in a dynamo machine, the current around the magnets and the current in the armature, and the relation of E.M.F. to currents is fully represented by a surface. In well constructed machines the effect of the latter is reduced to a minimum, but it can be by no means neglected. When a section of the armature coils is commutated it must inevitably be momentarily short-circuited, and, if at the time of commutation the field in which the section is moving is other than feeble, a considerable current will arise in that section, accompanied by waste of power and destructive sparking.

"Suppose the commutation occurs at an angle λ in advance of the symmetrical position between the fields, and that the total current through the armature be c, reckoned positive in the direction of the resultant E.M.F. of the machine, *i.e.*, positive when the machine isused as a generator of electricity. Taking any closed line through magnets and armature, symmetrically



drawn as A B C D E F A, it is obvious that the line integral of magnetic force is diminished by the current in the armature included between angle λ in front and angle λ behind the plane of symmetry. If m be the number of convolutions of the armature, the value of this magnetising force is $4\pi c \frac{m}{2} \frac{2\lambda}{\pi} = 4\lambda m c$ opposed to the magnetising force of the fixed coils on the magnets. Thus, if we know the lead of the brushes

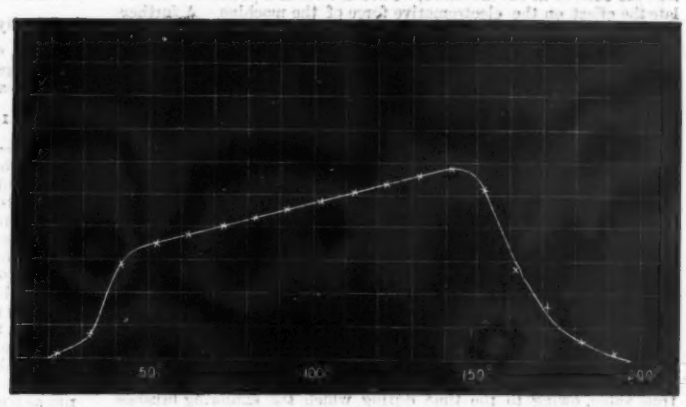


Fig. 2.

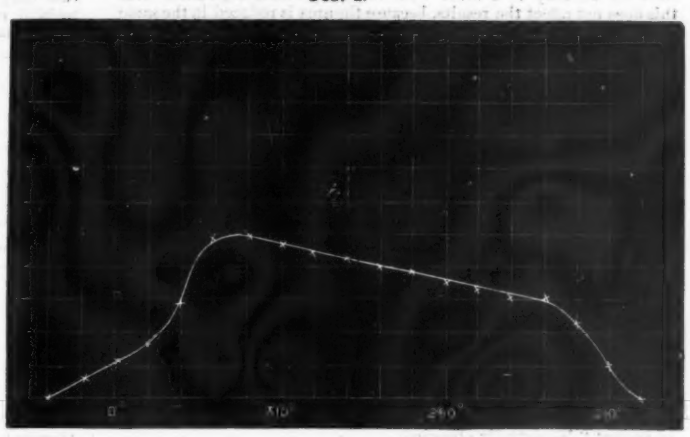


Fig. 3.

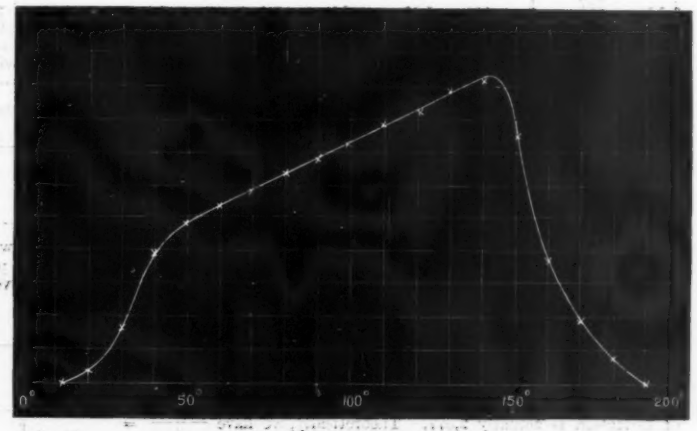


Fig. 4.

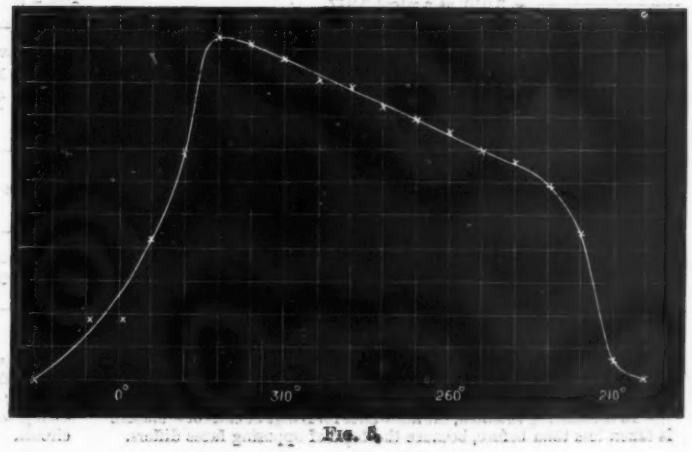


Fig. 5.

and the current in the armature, we are at once in a position to calculate the effect on the electromotive force of the machine. A further effect of the current in the armature is a material disturbance of the distribution of the induction over the bored face of the pole piece; the force along B C is by no means equal to that along D E. Draw the closed curve B C G H B, the line integral along C G, and H B is negligible. Hence the difference between force H G and B C is equal to $4\pi C \frac{m}{2} \frac{\kappa}{\pi} = 2\kappa m C$, where κ is the angle C O G."

To verify this formula is one of the principal objects of this paper.

A pair of brushes having relatively fixed positions near together, and insulated from the frame and from one another, are carried upon a divided circle, and bear upon the commutator. The difference of potential between these brushes was measured in various positions round the commutator, the current in the armature, the potential difference of the main brushes, and the speed of the machine being also noted.

The results are given in diagrams Nos. 2, 3, 4 and 5, in which the ordinates are measured potential differences, and the abscissæ are angles turned through by the exploring brushes. The potential differences in diagram No. 2 were measured by a Siemens voltmeter, and each ordinate is therefore somewhat smaller than the true value, owing to the time during which the exploring brushes were not actually in contact with the commutator segments. But this does not affect the results, because the area is reduced in the same proportion as the potential differences. In diagrams Nos. 3, 4 and 5, the potential differences were taken on one of Sir William Thomson's quadrant electrometers, and are correct.

Take diagram No. 2 in which machine No. 1 is a generator. A centimetre horizontally represents 10° of lead, and the ordinates represent differences of potential between the brushes. The area of the curve is 61·3 square cm., and represents 130 volts and a total field of $\frac{130}{104} \times \frac{1}{29} \times 10^8 = 4{\cdot}31 \times 10^6$ lines of induction. This is, of course, not the actual field, which is 3 per cent. greater on account of the resistance of the armature, but is represented by an area 3 per cent. greater. An ordinate of 1 cm. will represent an induction of $\frac{4{\cdot}31}{61{\cdot}3} \times 10^6 = 7{\cdot}0 \times 10^4$ lines in 10°. The area of 10° is 39·5 × 1·73 = 68·3 square cm.* Hence, an ordinate of 1 cm. represents an induction of 1,024 lines per square centimetre. The difference between ordinates at 50° and 140° is 2·5; hence the difference of induction is actually 2,560. Theoretically, we have $\kappa = \frac{1}{2}\pi m = 104\ C = 9{\cdot}4$. Therefore, $2\kappa m C = 3{,}072$, and this is the line integral of magnetising force round curve.

Let A be the induction at 50° and A + δ at 140°: these also are the magnetising forces. Hence (A + δ) 1·4 − A 1·4 = $2\kappa m C$; δ = 2,200 as against 2,560 actually observed.

Take diagram 3, in which No 2 machine is a motor. The total field = $\frac{107}{104} \times \frac{1}{20} \times 10^8 = 5{\cdot}15 \times 10^6$ lines of induction. Since the area of the diagram is 53·5 sq. cm., an ordinate of 1 cm. = $\frac{5{\cdot}15}{53{\cdot}5} \times 10^6 = 96 \times 10^4$ lines of induction in 10°. Hence, an ordinate of 1 cm. represents an induction of $\frac{9{\cdot}6 \times 10^4}{68{\cdot}3} = 1{,}400$ lines per sq. cm. The difference between ordinates at 320° and 230° is 2·0; hence the difference of induction is actually 2,800. Theoretically, we have $\frac{2\kappa m C}{l} = \frac{3\frac{1}{4} \times 104 \times 11{\cdot}4}{1{\cdot}4} = 2{,}666$, as against 2,800 actually observed.

In diagram No. 4, No. 1 machine is a generator. The total field = $\frac{52}{104} \times \frac{1}{12{\cdot}6} \times 10^8 = 3{\cdot}97 \times 10^6$ lines. The area of the diagram is 90·9 sq. cm., and therefore an ordinate of 1 cm. = $\frac{3{\cdot}97}{90{\cdot}9} \times 10^6 = 4{\cdot}37 \times 10^4$ lines in 10°. Hence, an ordinate of 1 cm. represents an induction of $\frac{4{\cdot}37 \times 10^4}{68{\cdot}3} = 639$ lines per sq. cm. The difference between ordinates at 50° and at 140° is 4·5; hence the difference of induction is actually 2,877. Theoretically, we have $\frac{2\kappa m C}{l} = \frac{3\frac{1}{4} \times 104 \times 12{\cdot}9}{1{\cdot}4} = 3{,}010$, as against 2,877.

In diagram No. 5, No. 2 machine is a motor. The total field = $\frac{63{\cdot}5}{104} \times \frac{1}{12{\cdot}3} \times 10^8 = 4{\cdot}96 \times 10^6$ lines. The area of the diagram is 112·2 sq. cm., and therefore an ordinate of 1 cm. = $\frac{4{\cdot}96}{112{\cdot}2} \times 10^6$ = 4·42 × 10⁴ lines in 10°. Hence, an ordinate of 1 cm. represents an induction of $\frac{4{\cdot}42}{68{\cdot}3} \times 10^4 = 647$ lines per sq. cm. The difference between ordinates at 323° and at 233° is 4·2; hence, the difference of induction is actually 2,718. Theoretically, we have $\frac{2\kappa m C}{l} = \frac{3\frac{1}{4} \times 104 \times 12{\cdot}3}{1{\cdot}4}$ = 2,870, as against 2,718 actually observed.

* In calculating this area, the allowance for fringe at ends of armature is taken less than before, because the form of opposing faces differs.

At page 345 of the paper on Dynamo-Electric Machinery it is shown that

$$I + \frac{\nu - 1}{\nu} 4\lambda m C \frac{A_2}{2 l_2} = F\left(4\pi n c - \frac{4\lambda m C}{\nu}\right),$$

where $I = F(4\pi n c)$ is the characteristic curve when $C = 0$, and λ is the lead of the brushes.

The following is an endeavour to verify this formula. The potentials both upon the magnets and upon the brushes were taken by a Siemens voltmeter, and are rough. The speeds were taken by a Buss tachometer, and there is some uncertainty about the precise lead of the brushes, owing to the difficulty in determining the precise position of the symmetrical position between the fields, and also to the width of the contacts on the commutator.

It was necessary, in order to obtain a marked effect of the armature reaction, that the magnet field should be comparatively small, that the current in the armature should be large, and the leads of the brushes should be large.

The two machines had their axles coupled so that No. 1 could be run as a generator, and No. 2 as a motor. The magnets were in each case coupled parallel, and excited by a battery each through an adjustable resistance. The two armatures were coupled in series with another battery and the following observations were made:—

	Potential on magnets in volts.	Potential on brushes.	Speed per minute.	Current in ampères.	Lead of brushes.
No. 1	24—24	66—67	880	102—103	26°
No. 2	29—29	86—84	880	102—103	29°

From which we infer:—

	Current in magnets.	$4\pi n c$	Corrected potential for resistance of armature.	Total induction I.
No. 1	1·78	8,900	70·8	$2{\cdot}30 \times 10^6$
No. 2	2·15	10,750	80·7	$2{\cdot}65 \times 10^6$

As there was uncertainty as to the precise accuracy of the measurements of potential, it appeared best to remeasure the potentials with no current through the armature with the Siemens voltmeter placed as in the last experiment. Each machine was therefore run on open circuits with its magnets excited, and its potential was measured.

	Potential on magnets in volts.	Potential on brushes.	Speed per minute.	Potential at 880 revs.
No. 1	25—25	90—90	880	90·0
No. 2	28—28	79—80	715—710	93·2

From which we infer, since we are upon a part of the characteristic which is practically straight; in which case, of course, the formula is reduced very nearly to

$$I = \frac{A_2}{2 l_2} (4\pi n c - 4\lambda m C).$$

	Potential on magnets.	Potential on brushes.	Induction $I = F(4\pi n c)$.
No. 1	24	86·4	$2{\cdot}82 \times 10^6$
No. 2	29	101·7	$3{\cdot}30 \times 10^6$

We have further—

$\lambda = 0{\cdot}45$ for No. 1. $\lambda = 0{\cdot}5$ for No. 2.

$\frac{4 m C}{\nu} = 2{,}920$ $\frac{\nu - 1}{\nu} 4 m C \frac{A_2}{2 l_2} = 443{,}800$.

	$4\lambda m C$	$\frac{\nu - 1}{\nu} 4\lambda m C \frac{A_2}{2 l_2}$	$4\pi n c - \frac{4\lambda m C}{\nu}$	$F\left(4\pi n c - \frac{4\lambda m C}{\nu}\right)$	$F\left(4\pi n c - \frac{4\lambda m C}{\nu}\right) - \frac{\nu - 1}{\nu} 4\lambda m C \frac{A_2}{2 l_2}$
No. 1	1,314	199,700	7,586	$2{\cdot}41 \times 10^6$	$2{\cdot}21 \times 10^6$
No. 2	1,460	221,900	9,290	$2{\cdot}90 \times 10^6$	$2{\cdot}68 \times 10^6$

It has already appeared that experiment gives for I in No. 1 $2{\cdot}3 \times 10^6$, and in No. 2 $2{\cdot}65 \times 10^6$. The difference is probably due to error in estimating the lead of the brushes, which is difficult, owing to uncertainty in the position of the neutral line on open circuit.

Institution of Electrical Engineers.

Authorised Abstract of Discussion on Mr. Reckenzaun's Paper, April 9th, 1892.

Mr. A. Snell had had some experience of tramway working in England, and considered that its success in the end was assured. Whether the final system would be an accumulator one, or a transmission one, he considered as yet uncertain. In the former the diagram related to one car only, and there were numerous cases of zero current when running down hill or stopping, whereas a transmission diagram referred to several cars at once. The periods of no current were shorter, and there were greater variations of current. The crux of the accumulator system lay in the accumulators themselves. On the Barking line there were four cars which ran 220 miles per day. Each car had three fresh sets of accumulators daily, and in bad weather four. Each run (out and back) was 2·35 miles. The charging engine ran from 10 to 12 hours, and gave on the average 450 E.H.P. hours. The energy given to the motors was not easy to determine, as the cells were sometimes run in series, sometimes two in parallel, depending on the number of passengers and the state of the roads. The drivers were always told to start with two in parallel and not to work in series if it could be helped. He estimated that the power averaged about 1 E.H.P. hour per car mile, or 220 E.P.H. per day, an efficiency of about 50 per cent. On an average line he would put engine and dynamo efficiency at about 77 per cent., accumulators at 60 per cent., and motor, gear, and starting devices at 60 per cent., a total efficiency of about 28 per cent. He preferred a single motor to two; there was sufficient adhesion on ordinary roads if the gradient were under 6 per cent. The combined efficiency with a two motor car was about 5 per cent. less than with a single motor one. Where there was a field for the former was for a line partly in town, where the pace was slow, and partly outside where the cars ran much quicker, the motors being used in series inside and in parallel out. With regard to gearing he had no experience of gearless motors, but thought they would be best if the stops were not frequent. Double reduction had the advantage that the motor was lighter, as it ran at higher speed.

Mr. Blackwell had had considerable experience in America. The great mistake that pioneers there, as here, had made, was that they calculated the power required, and calculated it much too low. The practice of one road was no criterion of that on another; they varied so much, both in gradients, state of the surface, and regularity of load. Their figures were often not comparable; the line which on paper appeared to be the most expensive often paying the best. The great difficulty in the last four years in America had been the gearing. All kinds had been tried, but he considered that single reduction held the field to-day. He was formerly much opposed to worm gearing, but was now partly converted, but would like to ask the author for some figures on the cost of working with various forms of gearing. As to cost he knew of no case where horses had been replaced on a line by electric traction in which there had not been a great increase of profit. The number of passengers often rose 70 per cent. and 80 per cent. With regard to Mr. Manville's remarks about interference with the telephones, he quite agreed with them. In America the telephone companies tried to get over the induction by using double wires, but found them a great nuisance.

Mr. Condict agreed that there would be a great advantage in the use of accumulators at the station as steadiers. He believed in the author's plan of dividing up the field magnets into sections for varying the power, and had gone further in America, where they sometimes used a double armature with a commutator at each end, the two being used either in series or parallel. He had obtained very good results with worm gearing, and had made some tests in which it came out very well compared to both single and double reduction gear. To the latter he was strongly opposed on account of its noisiness. With regard to weight of his cars, he would put car, battery, and motor, at 5,000 lbs. each, and 80 passengers at 12,000 lbs.

Mr. Jarman believed strongly in the accumulator system, especially as they could be put on any ordinary line with horse cars without altering the track. The present horse lines might be divided into two classes, those that paid and those that did not. The former did not want to change to power, and the latter could not afford to. In his own work, they often ran gradients of 1 in 16 with 68 passengers on a 44-passenger car. Accumulators now gave them but little trouble, but he was careful not to take larger currents from them than he could help. He preferred two motors to one, and always used them in series when possible. In reply to a question from the President, he could not give the cost per car mile, including cost of renewals, but proposed to read a paper on the whole subject at a future date. His cells had been running two years without renewals.

Mr. Sellon objected to the author saying that the expenses of the Blackpool line were 67 per cent. of the gross receipts. There was some £873 to be deducted for part of rent paid to the town, and other items, and this brought the figure down to 43·1 per cent. Two of the winter months, also, they were running at a loss. Taking from April to September only, the cost was £1,524 and the receipts were £5,570, giving 27 per cent. With regard to accumulator traction, he believed one set had run 4,000 miles with 785 discharges and no renewals.

Mr. Crompton said that the reason cells did not last was that the outer surface of the active material was always being jarred off. The right direction to work in was to try to get some non-pasted cell, and also to improve the springs of the cars. In crowded cities, he thought the accumulator system was the only feasible one.

Mr. Trotter said the diagrams nearly depended as much on mechanical details as on electrical ones. Much could be learnt from both accumulator and transmission diagrams as to the effect that a heavy flywheel on the engine would have. For integrating the curves to find the total amount of power, he drew them on the oiled paper used in copying letters, and then cut them out and weighed them, knowing the weight per square inch of the paper, which was very uniform. For a rough test, the curve, when cut out, could be balanced on a pencil to find the height of the line of average current.

Mr. Willans said the mean current appeared only to be 30 per cent. of the maximum, which was a very wasteful arrangement. Americans rather objected to using compound engines, on the ground that they were not economical at low loads; this, however, was not correct. It was true, however, that a compound had to be larger than a simple engine, as in the former steam would not be admitted during the whole stroke, as it could in a single engine on emergency. Mr. Baker had brought a dynamo with him from America with a 10-ton flywheel, and he thought a good deal was to be done in storage by that means. He agreed with a previous speaker that it would be well to start the motor free, and bring it into gear by a friction clutch, as it should save a great deal of loss in the leads, and the inertia would help the starting instead of opposing it, as it did when starting from rest.

Mr. Swinburne wished to know why such large horse-power was required—30 H.P. of motors on a car usually drawn by two horses. Mr. Field had told him he was running a car with a 2 H.P. motor coupled through rods, thus avoiding gearing loss.

Mr. Frazer said there was no need to use much power to start a car if you only did it slowly enough. The starting current at Barking, with all resistance in, was 40 A, and the running current about 30 A, the maximum being 70 A for 200 yards on a steep gradient. The voltage was 100.

Mr. Reckenzaun, in reply, said, with regard to the Southwark railway, it was running under different conditions to a tram line, being worked by signals it could be arranged that two trains should not start at once. He thought that if Mr. Baker had added a competent English engineer to his staff of American ones, he would have saved much of his preliminary expense. He spoke of the engine at Roundhay working much under power, its average output was certainly only 75 H.P., but a maximum of 165 H.P. being sometimes required the engine could not well have been much smaller. With regard to starting the motor light and then throwing it into gear, he had tried this nine years ago, and found it quite useless; even when there was a 120-lb. flywheel on the motor it was pulled up before the car started. The 17-ton car, mentioned by Mr. Russell, he thought a very excessive weight. The ordinary American cars, with passengers, weighed about nine tons. Two motors he considered much better than one, and American practice confirmed this view; mechanical coupling of the two sets of wheels he thought bad, as it produced so much friction. He quite agreed with Mr. Crompton's remarks on batteries. He could not quite understand the line which Mr. Swinburne spoke of as being said to run with 2 H.P.; he himself had begun with one 4-H.P. motor, but it would not do. The Americans now use two 15-H.P. motors. If one breaks down the other will run the car, and two together are wanted when a car leaves the rails. The pull required to start a car he had found from several tests was from 100 lbs. to 200 lbs. per ton.

DYNAMIC INDUCTION AT HIGH POTENTIALS AND FREQUENCIES.

By ELIHU THOMSON.*

It is the purpose of the present writing to supplement the experiments which were described by me a short time since, in which condenser discharges at comparatively high potentials were used to induce by dynamic induction similar discharges in parallel circuits or coils. The application of the principle to the production of an efficient lightning protector or device, affording a selective path for high efficiency discharges, has already been pointed out. So also the effects of the use of varying numbers of turns in the coils under induction have been shown; effects which have enabled me up to the present to obtain sparks of over 31 inches in length in free air between ball terminals about 1 inch in diameter and in an apparently continuous stream of not less than 250 per second. These sparks are bluish white, like Leyden jar discharges, and are accompanied by a loud rattle or roar. These effects and their bearing on insulation will be further adverted to.

The following experiment is an exceedingly instructive one, as showing the means I use for obtaining a balance of E.M.Fs. or selective path: Two coils of heavy wire are wound, each having about 12 to 15 turns, more or less. The coils are separated by a glass cylinder, one coil being in the interior of the cylinder and the other being wound outside thereof. Connections are made as in fig. 1. The turns of the coils should be kept apart, or well insulated from one another. An incandescent lamp, L, is put in circuit with one of the coils, as the outer one, by putting one terminal of the lamp in connection with one end of the inner coil and the other lamp terminal to one end of the outer coil. The wires, *a*, *b*, permit condenser discharges to be passed through the

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inner coil; a branch wire, c, is taken from *b*, and its free end can be connected to any part of the outer coil so as to include more or less of the turns of the outer coil in a branch with the lamp around the inner one. With, say, 12 turns in the inner coil, and a possible change of the turns of the outer coil from none to 15 or 16, and passing condenser discharges over an air gap at J with an air blast playing on the spark to prevent continuous arcs, when the condenser charges are furnished by the high potential secondary of an alternating current transformer, the lamp at L would be lighted to a greater or less brilliancy according to the turns of the outer coil in use. In applying the movable wire to the outer coil at a certain point, there is found to be no current passing in the lamp, and on passing this wire either way from this point so as to include more or less of the outer turns, the lamp is lighted with gradually increased brilliancy as the neutral point is more and more departed from. Of course a current indicator, provided it responds to currents of excessive frequency, may be substituted for the lamp. This experiment shows in the clearest manner the fact, that a selective path for the discharges of high potential is obtained in adjusting the relative number of turns in the outer and inner coils.

Fig. 1.

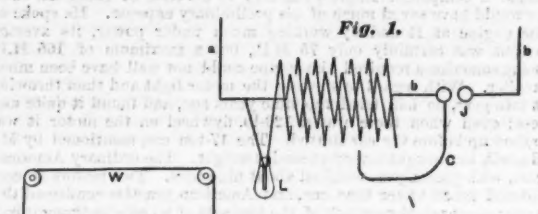


Fig. 2.

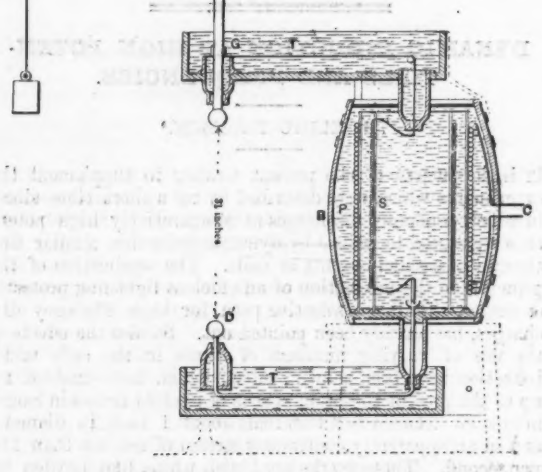
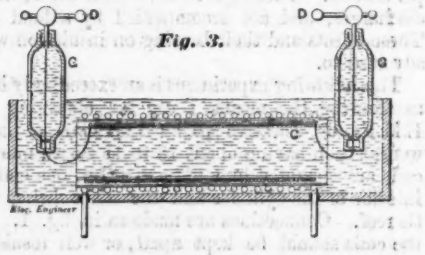


Fig. 3.



I have in a previous communication stated in what way this combination of inductive coils has been applied as a lighting arrester or protective apparatus for dynamos, motors, transformers, &c. Varying the spark length at J or the condenser capacity does not, so far as has yet been determined, disturb the relations found. It is, of course, necessary that the two coils be well insulated from each other, and this can easily be done by immersion in oil or separating them by glass, hard rubber, or the like.

I will now describe certain forms of apparatus which are adapted for obtaining, at will, very high potential discharges. In fact, I have been able easily to obtain from about 1,600 feet of wire, sparks of over 31 inches between the discharge balls. So far as can be estimated from available data, these sparks are due to potentials of not less than half-a-million volts.

In fig. 2, B is a barrel of lubricating oil, an oil of high insulating qualities, being in fact a liquid paraffin. The top of B is open, and in it are immersed the primary and secondary coils, P and S, each wound on a paper cylinder. The cylinder on which S is wound is about three inches smaller in diameter than the other, and has an external diameter of about 13 inches. It is covered with two layers of silk, and upon this is wound 500 turns of No. 26 cotton-covered wire in one layer with a silk thread between the turns. This layer covers about 20 inches of the length of the cylinder. The terminals of this fine coil are carried out respectively through the lower head and up through the oil above, as will be described.

The primary, P, consists of fifteen turns of a conductor composed of five rather heavy wires laid alongside, and the connections are made by carrying the terminals outside at C, keeping them about 2 inches apart. The wire leaving S downward goes to a rod which rests in a cup in the centre of the bottom head of a barrel. This cup has a rod extending down through a glass cylinder filled with oil which dips in a horizontal trough of oil, T, through the centre of which is carried a prolongation of this rod to conduct the discharges to the lower discharge terminal, D.

The upper end of S is treated in a similar way, passing up through a cork in a glass vessel, such as an inverted bottle with the bottom perforated, then horizontally in the trough, T, of oil to the sleeve, G, through which a hollow brass bar, D, with rounded ends, may be slid up and down. For this purpose a string and pulley with counter-weight, W, may be provided. The bar, D, should be, say, an inch in diameter to avoid brush discharges from its sides, and in fact, its upper end should be covered with a bottle of oil or have a large polished ball; otherwise large brush discharges will pass into the air from it. By means of a condenser and spark gap with a blast of air blowing across the gap, the apparatus may be used to obtain the high potential and high frequency sparks. The charging of the condenser is from the secondary of a high potential induction coil given about 15,000 to 20,000 volts, the primary of which coil is fed from alternating current mains. The condenser used in the experiments consisted of 16 Leyden jars of about a gallon each, which was all there was at command. This will be replaced by a special condenser adapted for such work. The discharges from the apparatus are, as stated, over 31 inches long, and this distance is the maximum that can be given to the space between the terminals as the apparatus is constructed.

The power of the discharge is exemplified by the ease with which glass plates are punctured. Heavy pine or even oak boards are perforated and set on fire. The discharges scorch a black line where they pass over a surface of wood, and soften glass where they locate themselves in passing over a sheet. A stick of wood placed between the terminals, and joining them, is splintered and torn by the discharge, and is found covered with a fur of fine splinters. Glass vessels are shattered in the line of the discharges, and inflammable matter is set on fire. Perhaps the most beautiful effect is obtained by the insertion of a plate of glass between the electrodes when separated about 24 inches. If the glass be thick enough to resist perforation, the discharges spread all over it, and pass around the edges, producing an almost indescribably beautiful effect, especially in a feebly lighted room, which allows all the minor ramifications of sparks to be seen.

The induction in the fine secondary of the apparatus is about 1,500 to 2,000 volts for each turn, which would give 750,000 to 1,000,000 volts total for the 500 turns. But on account of condenser actions absorbing a part of the discharge it is probable that the effective electromotive force between terminals may not much exceed 500,000. We have no ready means of measurement of such pressures. A very simple and inexpensive form of apparatus for obtaining these high

potential discharges is shown in fig. 3. It consists of a wooden trough, the joints of which are capable of holding oil; its parts may be nailed or screwed together in the ordinary way with shellac or white lead.

The primary coil of ten turns lies against the sides of this trough, and the secondary layer may be an ordinary wire, heavily insulated with cotton and wound on a cylinder of paper, C, or cardboard covered with dry muslin or silk. If the turns are not over six inches in diameter the cotton insulation between turns will suffice, if rather thick, say, $\frac{1}{100}$th of an inch, or over.

The secondary terminals are taken out at the centre of the ends of the cylinder, as shown, and led up through a glass vessel, G, which may be conveniently made of two bottles with the bottoms removed and cemented together; or a specially blown glass vessel may be used instead. Its object is to hold oil and cover the secondary terminals to a height sufficient to remove them far enough to prevent discharges passing over the surface of the oil in the trough which is used to cover the coils, as indicated. The discharge terminals, D, D, pass up and outward from the bottles and the sparks are obtained between them. The simplicity of construction is evident, a trough 4 feet long will hold a coil capable of giving a spark discharge 3 feet long. By coupling up two such troughs in tension this effect may doubtless be doubled, if required.

It is important, of course, that all connections, leads from the condenser to the primary coil, &c., be as short and as free from self-induction as possible, or the rate of oscillations on which the high inductions depend will be lessened and the effects be weakened to some extent. The potential given by a secondary coil of a certain number of turns depends, of course, on the rapidity of magnetic change and the extent of such change, or maximum densities of field attained. The greater the number of turns in the primary, the greater will be the field strength if the same current flows in every case. But increasing the number of primary turns slows the oscillation rate and diminishes the maximum current value and so diminishes the magnetic density. There is evidently to be selected, therefore, for each condenser, that number of turns which will give the highest product of the rate of change and the extent of change or maximum field.

As a striking illustration of the slowing effect of numerous turns of wire on the periodicity or rate of change, it may be mentioned that if, instead of passing the condenser discharges through a coarse coil of few turns, using the spark gap and charging transformer as before, they be passed through a well insulated coil of many turns of comparatively fine wire, the discharge rate may easily be brought down low enough to cause the spark to whistle along with the sound of the alternating discharges of 125 periodicity used in the charging transformer. The introduction of a well-made iron wire core greatly lowers the tone obtained. It is conceivable that an approximation to music might be obtained from spark discharges sent through coils of such varied inductance, as to cause the rates of oscillation to follow those of the musical scale.

In the conduct of the experiments on high inductions, which have been described, one cannot fail to be impressed with the capabilities of oil as an insulator. The perforation of two inches of oil between rounded terminals of, say ½ inch diameter, would seem to demand a potential capable of causing a leap of five feet in air. It appears to be true that edges or points under oil or imbedded in any insulating medium are effective in inducing puncture for the same reasons as they are effective in discharging through air. They act as electric wedges and concentrate the di-electric strains upon those parts of the insulating medium directly in front of such points or edges. Hence, the most perfect insulation to resist puncture in oil or air demands smooth surfaces of as large diameter as possible. This is, of course, a different matter from insulation resistance or power of resisting leakage.

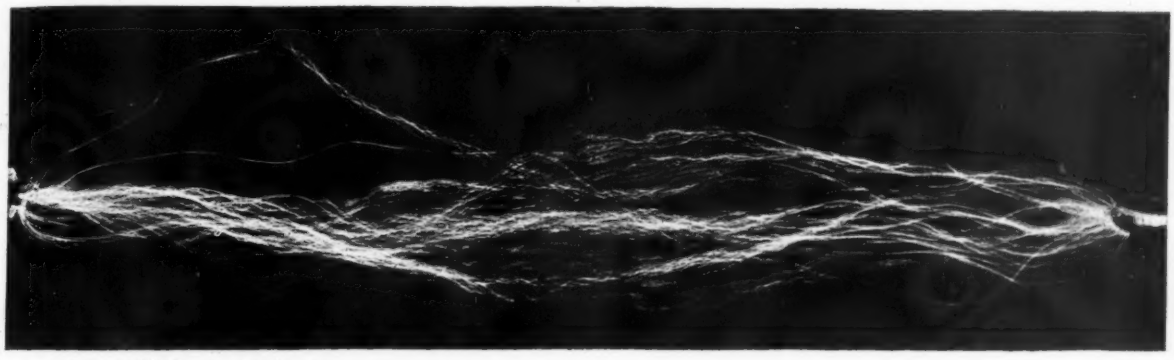


Fig. 4.—Dynamic Induction Discharge through 30 Inches of Air, at 500,000 Volts.

NEW PATENTS—1892.

5,971. "Improvements in underground conductors for the distribution of electricity." S. W. Baynes. Dated March 28th.

5,982. "Improvements in joints and connections for electrical purposes." A. H. Sanderson. Dated March 28th.

5,988. "Improvements in or relating to the distribution of electricity." J. S. Raworth and W. Geipel. Dated March 28th.

5,999. "An improved method for preventing induction." Sir C. S. Forbes. Dated March 28th.

6,006. "Improvements in the treatment of electro deposits of metals." T. Parker and A. E. Robinson. Dated March 28th.

6,007. "Improvements in or connected with cells for electrolysing chloride solutions." T. Parker and A. E. Robinson. Dated March 28th.

6,015. "Improvements connected with shades and shade or reflector holders for incandescent electric lamps." R. R. Harper. Dated March 28th.

6,050. "Improvements in insulated electric conductors." W. P. Thompson. (Communicated by J. B. Williams, United States). Dated March 29th. (*Complete.*)

6,058. "Improvements in machinery for the purpose of hardening and tempering metals by electricity." W. F. Taylor. Dated March 29th.

6,061. "Improvements in telephone switchboards." A. Whalley. Dated March 29th.

6,083. "Improvements in incandescent electric lamps." F. S. Smith. Dated March 29th. (*Complete.*)

6,088. "Improvements in the manufacture of filaments for incandescent electric lamps." M. Boehm. Dated March 29th.

6,095. "Improvements in conductors for electric railways or tramways." R. Belfield. Dated March 29th.

6,105. "Improved method of and apparatus for lessening or preventing incrustation, corrosion, and pitting in steam generators, and apparatus for imparting heat to water, which invention can be applied in connection or not with electric lighting apparatus. J. Bennett and J. Tellefsen. Dated March 29th.

6,112. "Improvements in and relating to secondary batteries or accumulators. H. H. Lake. (Communicated by W. Sleicher, jun., and G. A. Mosher, United States.) Dated March 29th. (*Complete.*)

6,119. "Improvements relating to electric railways." M. Cattori. Dated March 29th. (*Complete.*)

6,122. "An improvement in the construction of electric arc lamps." E. C. Russell. Dated March 30th.

6,145. "An improved electric railway system." E. M. Boynton. Dated March 30th.

6,152. "An improved material or fabric for applying magnetic, galvanic, or other currents for curative or medical purposes. T. Field, jun., J. Worsfold, and H. S. D. Brayn. Dated March 30th.

6,181. "Improvements in or relating to automatic electric fire-alarms." L. G. Woolley. Dated March 30th.

6,232. "An improved process for electrically renovating, resurfacing, and welding, fusing, or brazing strainer plates used in

paper making, brewing, and other industries." H. J. ROGERS and J. PARAMOR. Dated March 31st.

6,246. "Electro-magnetic variable speed gearing." W. W. BEAUMONT. Dated March 31st.

6,253. "Improvements in apparatus for propelling vehicles by electricity upon railways and tramways." A. S. CHURCHILL. Dated March 31st.

6,259. "Improvements in the manufacture of filaments and other light-emitting bodies for electric glow lamps, and apparatus therefor." E. BAILEY. Dated March 31st.

6,288. "Improvements in or connected with the manufacture of alkalies, chlorine, and hydrogen by electrolysis." H. C. BULL. Dated April 1st.

6,289. "Improvements in the deposition of metals by electrolysis, and in apparatus therefor." J. C. GRAHAM. Dated April 1st.

6,293. "Improvements in motors and dynamos." J. GIBSON. Dated April 1st.

6,312. "An electrical apparatus for starting gas engines and other prime movers." C. W. HILL and E. HUGHES. Dated April 1st.

6,313. "Improvements in receptacles for electric and other wires, gas piping and the like." T. G. HARTLAND and J. EVANS. Dated April 1st.

6,344. "Improved apparatus for straining or taking up slack in wires, cables, strips, or the like, more especially intended for straining electric conductors between their supports." C. J. BARLEY and M. FEETHAM. Dated April 1st.

6,345. "Improved electric hammer for dental and other purposes." H. NEHMER. Dated April 1st.

6,348. "Improvements in electrical relays." W. S. SMITH and W. P. GRANVILLE. Dated April 1st.

6,364. "Improvements in electric arc lamps." H. H. LAKE. (Communicated by H. Wilbrant, Belgium.) Dated April 1st.

6,402. "Improvements in the means of preventing interference of electric currents used in tramways, telephones, &c." G. FORBES. Dated April 2nd.

6,405. "An improvement in secondary voltaic batteries." D. URQUHART and J. M. SMALL. Dated April 2nd.

6,406. "Magnetic rolling apparatus." F. E. ELMORE and A. S. ELMORE. Dated April 2nd.

6,428. "Improvements in the manufacture of elements for electric or secondary batteries." E. HANCOCK and A. J. MARQUAND. Dated April 2nd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

303. "Improvements in electric railway systems." C. K. HARDING. (Under International Convention.) Dated June 9th, 1890. 11d. Relates to an improvement in electric railway systems of that class which embraces a central generating plant, electric motors upon the vehicles to be propelled, and conductors through which the current generated is conveyed to the several motors; and one of the principal objects of the invention is to provide an improved construction in means for distributing the electric current from a dynamo or generator to a series of electric motors upon vehicles or trains, by which the employment of overhead or other exposed supply conductors carrying the current from the generator to the motors may be dispensed with, thereby ensuring entire safety from accidents liable to occur wherever exposed conductors are employed. 16 claims.

1,963. "Improvements in methods of and apparatus for electrically soldering cans and other sheet metal ware." M. W. DEWEY. Dated February 3rd. 8d. Consists, broadly, in electrically heating a metal tool, suitably applying the solder or cement to the junction of the pieces, bringing the tool in contact with the solder, and then moving the tool along the said junction. 11 claims.

2,061. "Improvements in electric lamp-holders. W. P. THOMPSON. (A communication from abroad by J. B. Moore, of America.) Dated February 4. 8d. Relates to spring clasp electric lamp-holders, and the object of the invention is to provide a device for attachment to an incandescent electric lamp by means of which the same may be readily attached to a desk, table, or other support, or may be supported upon a desk or table, and to make the lamp readily movable with respect to said clasp. 8 claims.

2,334. "Improvements in and relating to electrical communicators for use on public vehicles and the like." J. W. EYRE and C. GRAHAM. Dated February 9th. 6d. The object of the invention is to enable the drivers of vehicles, such as cabs, to be guided in any required direction by the passenger. For this purpose, the inventors construct a case or box of metal, wood, or suitable material, one side of which is enclosed by a sheet of glass, mica, or other transparent material. This is placed with the open side towards the driver, on the splash board of the vehicle, or, in the case of a "hansom," below the fork or rein guide, or in other suitable position. Inside this box is placed one or more, but, preferably, three incandescent lamps, to signify right, left, or stop, having corresponding buttons or pushes in the most convenient position inside the vehicle in connection therewith. An ordinary battery may be carried on any part of the vehicle, having the usual electrical connections. By pressing the corresponding button the passenger can direct the driver on the darkest night. 1 claim.

2,862. "Improvements in electric fire engines, also applicable to other electrically-propelled vehicles." M. W. DEWEY. Dated February 17th. 8d. Consists in providing the electric fire engine with a secondary battery to be carried thereon, to supply current to the electric motor on the engine; and in providing means whereby the electric motor on the engine for operating the pump may be disconnected from the pump and connected to the engine to propel it, when desired. 26 claims.

3,349. "Improvements in electric welding apparatus." M. W. DEWEY. Dated February 24th. 8d. Relates to certain improvements in apparatus for electric welding, and is especially applicable to the heating of curved forms, such as rings, hoops, tires, &c. The object of the invention is to provide simple and efficient means for rapidly welding the ends of pieces or a ring together. 11 claims.

4,751. "Improvements in electrical transportation systems." O. IMRAY. (Communicated from abroad by S. S. Wheeler and C. S. Bradley, both of New York.) Dated March 17th. 8d. Comprises a fixed railway of any suitable character, one or more stationary alternating current generators, a car adapted to travel along the railway, and formed in whole or in part of inductive material, and two or more specially arranged inducing conductors carrying two separate alternating currents of different phase. 7 claims.

4,758. "Improvements in electric railways." A. M. CLARK. (A communication from abroad by the Waddell-Entz Electric Company, of New York.) Dated March 17th. 8d. Consists mainly in the employment of a continuous armature, which armature is stationary, and which extends from end to end of the track to be traversed by the vehicle. The armature exercises its force upon a field magnet, which is carried by the vehicle to be propelled with the aid of brushes or analogous contact devices, that also travel at the same rate as the vehicle, and that convey the current from mains or conductors which are laid along the route to that portion of the armature which is under the influence of the field magnet. 12 claims.

4,792. "Electric type writers." E. J. SILKMAN. Dated March 17th. 1s. 1d. Relates to type-writing machines of a class in which the actuating of a key throws into operation mechanism driven by electro-magnetism, which automatically brings the proper letter into correct position, prints it, and successively imparts the necessary feeding, spacing, and reverse movements of the apparatus, so as to print the page. 30 claims.

4,838. "Improvements in incandescent electric lamps." M. BAILEY and J. WARNER. Dated March 18th. 6d. The conductor is formed of carbon admixed with calcium oxide, and is wound helically and formed into a ring divided at its semi-diameter; the ends of each are then united and secured to the leading-wires conveying the current. 2 claims.

5,252. "Electric signal apparatus for railway trains." E. D. GRAFF. Dated March 24th. 1s. 1d. Relates, first, to means for electrically signalling between two approaching trains on the same track; secondly, to means for signalling an approaching train when the train immediately preceding it on the same track has stopped or for any other reason has failed to pass out of a prescribed block or predetermined section; and, thirdly, to means or mechanism whereby the signalling devices are regulated or controlled so as to be operable to give the desired notice to the engineers of approaching trains and to the engineer of a train which may come within a block or section of the track before a preceding train has passed out therefrom. 14 claims.

5,983. "Improvements in or connected with means or apparatus employed in electrolysis." E. A. LE SUEUR. Dated April 7th. 8d. The object of this invention is to produce an apparatus which shall be durable, cheap, efficient, compact, and of low resistance, and in which those parts which deteriorate in use, particularly the diaphragm and the positive electrode, may be readily removed and replaced when desired. 14 claims.

6,003. "Terminals for cables of electrical conductors." J. C. REILLY. Dated April 7th. 8d. The object of the invention is to provide a suitable and effective device for preventing access of air and moisture to the insulated conductors of a sheathed cable, which device at the same time furnishes a means for distributing the several conductors forming the cable, and separately connecting them to isolated or independent conductors. 8 claims.

6,881. "An improved method of and apparatus for covering electric wires." J. E. WALCOTT. Dated April 21st. 8d. Relates to the protecting covers or sheaths of insulated or non-insulated electric conductors, and the object of the invention is to produce, by means of a rapid and continuous method, an improved form of covering or sheath which shall perfectly encase the wire or wires, and which shall be capable of enduring, without detriment, all of the strains, including handling, coiling and suspension, to which this class of structures is subjected. 4 claims.

6,963. "Improvements in means for staying telegraph, signal, and other posts, poles, or masts." C. E. SPAGNOLETTI. Dated April 22nd. 6d. Consists of an iron plate, constructed in such a manner as to enable a stay rod or stay wire to pass through it, and to be held at its under side by a nut. The plate of iron is slightly concave preferably, and varies in size and weight according to the requirements of the posts, poles, &c., and also according to the resistance required. Through a hole in the centre of the plate a rod or wire is projected, and at each side of the hole is arranged a rib to secure the head of the rod or stay wire, and to prevent it turning round when being screwed or otherwise manipulated. Ribs are provided at the back of the plate for the purpose of strengthening it. The plates can be buried at any required depth according to the work they have to perform, and the stay rod may be riveted, soldered, or otherwise attached to the plate as required. 2 claims.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

Siemens's Railway Signalling Apparatus.

Among the multifarious exhibits of Messrs. Siemens Brothers, one of great interest is their railway signalling apparatus. The Siemens Railway Gong-Alarm serves the following purposes :—

1. To inform the gate keepers at level crossings, or the men placed at special points along the line, of the starting of a train, thus increasing the vigilance of these men and the security and punctuality of the railway service.

2. The gong signals, being heard distinctly up to a distance of about 500 yards from the keeper's hut, cannot fail to draw his attention to the approaching train, thus indicating when the gates must be closed, and when the visual signals, points, &c., should be placed in their proper positions. The public is thus prevented from crossing the line at the approach of a train.

3. By means of the gong apparatus signals of alarm can also be sent from either the up or down stations to the huts of the men guarding the line, or from the latter to the stations.

The *modus operandi* of gong signalling is effected in many different ways, and depends principally upon the system adopted by the various railway administrations for the working of their traffic; and to which systems the gong signalling service has to be accommodated.

Gong alarums can also be used in combination with any previously adopted system of railway telegraphs, or of block signalling apparatus, so that the instruments hereafter described may be considered as suitable for adaptation to the telegraph system already adopted for the working of any given railway line.

The gong alarum pillar (see figs. 1 and 1A) consists of a cylindrical iron pillar enclosing a clockwork which is fitted with one or more striking levers, according to the number of gongs on the pillar, and which are brought into action by an electro-magnet. The armature of this electro-magnet, by the attraction of which the striking gear is released, is best actuated by continuous currents from a magneto-inductor.

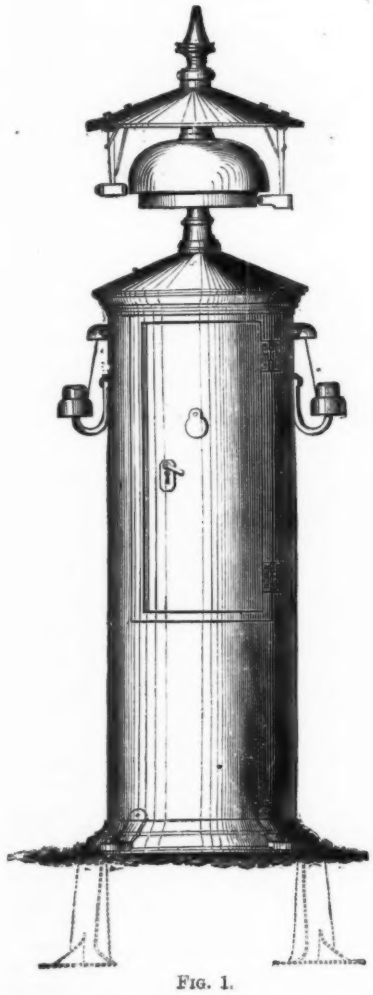


Fig. 1.

Fig. 1A.

The current enters the pillar by one of the line wires (see fig. 1A) which passes through the porcelain guide attached to the pillar, and is then led to one plate of a point-lightning arrester, the current then passes through the coils of the electro-magnet, returning to the second plate of the lightning discharger, and thus into the second line wire to the next gong pillar and so on.

These pillars are so constructed that the weight actuating the clockwork has a vertical descent of about four feet (1·25

metre), this being sufficient for one day's signalling. Each pillar is also provided with four cast iron legs for fastening it to either a cement or brick foundation, or to wooden sleepers.

The gong alarum clockwork (see fig. 2), is placed on a frame inside the pillar, as shown in fig. 1A. The wheelwork is driven by a weight, suspended by a steel cord. The large wheel attached to the barrel has a number of pins projecting at its face, and, when the barrel rotates, these pins act upon the levers of the striking gear, thus producing a corresponding number of strokes upon the gong. This takes place whenever a current exceeding a certain strength traverses the electro-magnet, the armature being then attracted and the lever, which, in its normal position arrested the wheelwork and striking gear, being set free and allowing the wheelwork to rotate and causing the gongs to be struck.

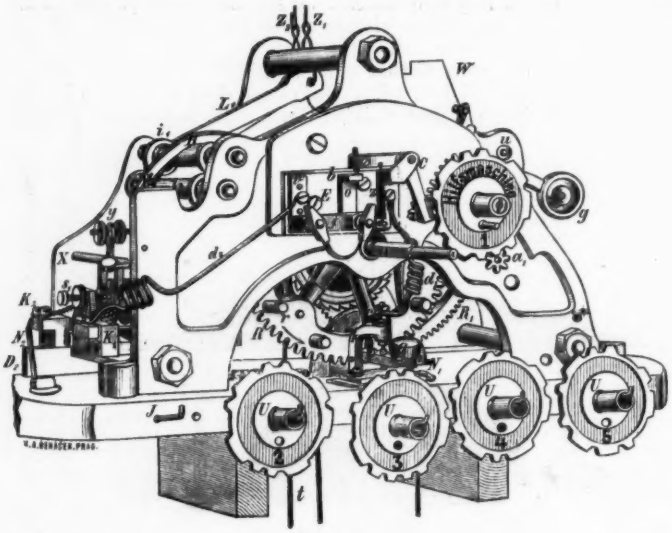


Fig. 2.

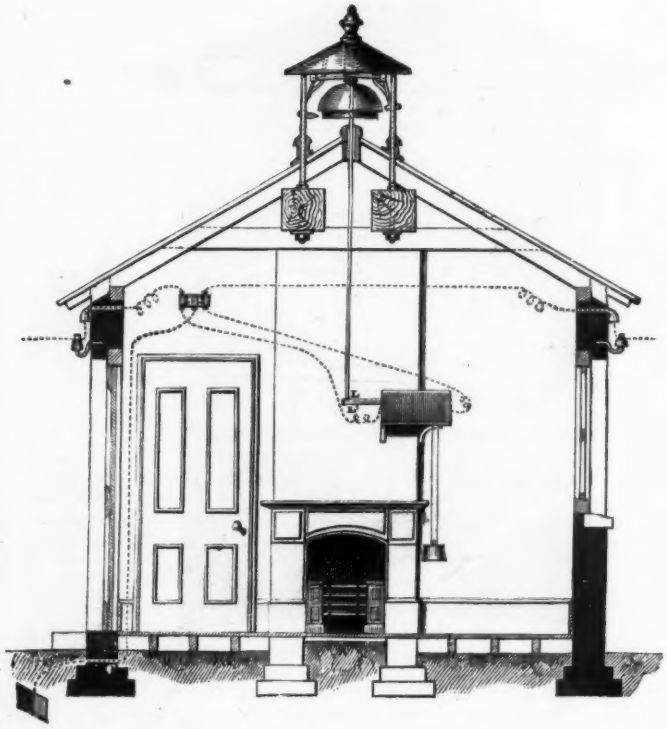


Fig. 3.

After each rotation of the large wheel, however, the lever is brought back into its normal horizontal position by means of one longer pin, a flat filed on its axis being brought into such a position that it now engages a stop attached to the spindle of the flywheel, thus bringing the clockwork to rest, when the gong also ceases to sound. The end of the lever is at the same time caught by a pawl attached to the armature of the electro-magnet, and the normal position of rest is thus re-established.

According to the number of projecting pins on the face of the large wheel, and, according to their grouping, a great variety of signals can be obtained, but as a rule the gong pillar alarums are so arranged that, on the striking gear becoming released, either one stroke, or 2, 3, 4, 5, 6, 10 or 12 strokes are given.

The gong pillars are generally provided with two hammers, and two gongs of 20 inches and 16 inches diameter (equal to 50 and 42½ cm. respectively).

The vast range allowable in the different groupings of the elements of a signal, and also the production of them on apparatus composed of either one, two or more gongs, makes it easy to choose signals very different in sound, a circumstance which becomes a necessity at places, where gong apparatus of two or more railway lines are placed in close proximity to one another.

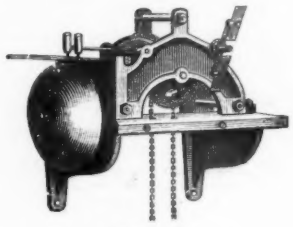


Fig. 2A.

Gong pillar signals are, as a rule, worked by open circuit currents, the electro-magnets having a resistance of 10 ohms. But where the other telegraphic arrangements may require it the apparatus is adapted either for the closed circuit system, or for being worked by alternating currents.

It is sometimes found advantageous to place the gong alarum apparatus inside the gatekeeper's house, while the gongs are erected above the roof.

In those cases where the gong signals have to be received in station offices, or on platforms, where the loud sounds of the normal gongs are not required, station gong apparatus are supplied instead of the ordinary pillar gong alarum. These instruments, shown in fig. 2A, are similar in construction to those used within the pillars, but they are of a smaller size, made of brass and generally mounted on a mahogany wall bracket, with a protecting case and two bells. The clockwork is here wound up by pulling the free end of the chain, and without the help of a key. This alarum apparatus acts simultaneously with any other gong placed along the line.

Fig. 3 is a vertical section of a small house or hut, which serves as a dwelling for the gatekeeper, the hut being erected at a level crossing or other place where a gong is required. The clockwork is enclosed in a protecting case, and the ends of the two striking levers, L, L^1, are connected, as shown in the figure, with the two hammers which strike the bells, by means of cords passing through the roof. The electrical connections with the line wires, lightning discharger and earth are indicated by dotted lines.

(To be continued.)